

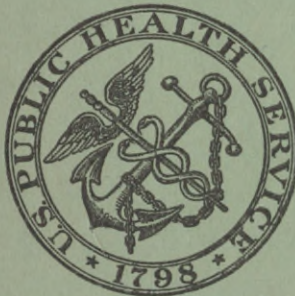
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PUBLIC HEALTH BULLETIN

No. 269

**THE HEALTH OF WORKERS
IN DUSTY TRADES**

VII. Restudy of a Group of Granite Workers



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Public Health Bulletin No. 269

THE HEALTH OF WORKERS IN DUSTY TRADES

VII. Restudy of a Group of Granite Workers

By

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PREPARED BY DIRECTION OF THE SURGEON GENERAL



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FOREWORD

The progress of silicosis is a subject of great interest to industrialists, to industrial hygienists, and to jurists. Opportunities to make extensive studies of the condition have been rather limited, but observations made on a group of granite workers in Vermont in 1924-26 and again in 1937-38 make possible a rather detailed inquiry into the progress of this condition.

In 1924 the Public Health Service undertook the study of the health of workers in dusty trades. Investigation of the effects of exposure to siliceous dust was under the direct charge of the author of the present report. The findings of the earlier study were published as Public Health Bulletin No. 187, *The Health of Workers in Dusty Trades. II. Exposure to Siliceous Dust (Granite Industry)*.

In 1937-38 the same workers were reexamined. The results of this second study are the subject of the present report. X-ray photographs available from the earlier survey are presented together with photographs made in 1937-38 for the purpose of illustrating the changes which have occurred during the interim. In linking the two studies it has been necessary to review briefly the original study as it relates to working conditions, physical examinations, and morbidity.

New material herein presented discloses the effect of exposure to granite dust of known concentration and silica content. The original study was followed up after a lapse of from 12 to 14 years. The different results due to this same dust in varying concentrations are shown, and form the basis for recommendations for control measures. This is one of the most important points brought out in this report. It has been demonstrated in this present study, that in the same industry there were differences in reaction to the dust hazard in direct proportion to the intensity of dustiness. This finding emphasizes the futility of trying to evaluate the extent of dust hazards without dust counting.

Confusion has arisen in the past when the results of one study of dust exposure have been compared with another where the concentration and the silica content varied. Most notable in this regard are the early attempts to classify silicosis in the United States according to the standards in South Africa where the silica content of the dust is very high and the workers and their living conditions are quite different from those in the United States.

The diagnoses of tuberculosis in cases presented herein were made on the basis of physical examinations and laboratory reports rather than the X-ray alone.

The present report deals primarily with the reexamination of as many as possible of the identical workers who were examined in the 1924-26 study. There were 642 granite workers examined during that period. There have been more than 150 known deaths in this original group since the close of the original study (October 1926). Fifty-eight of the original workers studied refused to return for reexamination. Some of the workers who were examined in the original study had moved away and information concerning their status and the condition of their health was not obtainable. There remained 116 workers on whom examinations had been made both in the original study and in the restudy in 1937-38.

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THE HEALTH OF WORKERS IN DUSTY TRADES

VII. RESTUDY OF A GROUP OF GRANITE WORKERS

RESUMÉ OF THE 1924-26 STUDY OF GRANITE WORKERS

The Public Health Service began a series of studies in 1924 dealing with the health of workers in dusty trades. The method of approach in each of these studies was the same insofar as this was possible. The procedure employed was largely as follows:

1. Study of absenteeism—its causes.
2. Physical examinations, X-rays, laboratory examinations, autopsies, etc.
3. Statistical analysis of mortality data—local and general, where applicable.
4. Study of environment of workers—industrial processes, dustiness, chemical and petrographic analyses of dust.
5. Study of remedial measures—ventilation, effect of change of processes, effect of protective equipment, and efficiency of protective equipment.

Studies were reported in the following bulletins under the general title, The Health of Workers in Dusty Trades:

- I. Health of Workers in a Portland Cement Plant, Public Health Bulletin No. 176. *1928*
- II. Exposure to Siliceous Dust (Granite Industry), Public Health Bulletin No. 187. *1929*
- III. Exposure to Dust in Coal Mining, Public Health Bulletin No. 208. *1933*
- IV. Exposure to Dust in a Textile Plant, Public Health Bulletin No. 208. *1933*
- V. Exposure to Dust in a Silverware Manufacturing Plant, Public Health Bulletin No. 208. *1933*
- VI. Exposure to Municipal Dust (Street Cleaners in New York City), Public Health Bulletin No. 208. *1933*

In the first report a discussion set forth in some detail opinions of authorities as to the nature of pneumoconiosis caused by the different kinds of dust, although a review of all of the literature available on the subject at that time was not attempted.

A general summary and statement of findings was given in Bulletin No. 208.

Prior to 1924, when these studies were begun, knowledge of the effects of industrial dust hazards on the health of workers had been gained largely from a study of occupational mortality statistics or from physical examinations of sample groups of employees in various industries. The exception to this was the study by Dr. A. J. Lanza of the Public Health Service of 433 cases of miners' consumption among zinc miners in southwestern Missouri; a report of the findings was published in 1917, in Public Health Bulletin No. 85.

CHEMISTRY AND CONCENTRATION OF DUST

It was shown by petrographic analysis that granite dust in Barre, Vt., contained 30 to 35 percent of crystalline silica or quartz. Concentration and size of dust particles are a part of the etiology of silicosis and rank in equal importance with the chemistry of the dust. It is necessary to know the concentration of a dust before a definite decision can be made whether such dust is harmless. A toxic dust in a low concentration may not produce a disabling silicosis, but when the threshold of tolerance is passed, the disease will develop at a rate proportionate to the concentration and to the percentage of free silica present. This was exemplified in the study of the various dust count groups of the granite industry.

Two hundred and twenty dust determinations were made on the various occupations in the industry. The concentration ranged from an average of 60 million particles per cubic foot for the workers using hand-pneumatic tools, down to 2 million particles per cubic foot for the office workers. The average exposure for the operators of surface cutting machines was 44 million particles; for carvers and letterers, 37 million particles; and for tool grinders, 27 million particles. The dust to which the tool grinders were exposed was wet. The average plant dustiness was about 20 million particles per cubic foot.

For the purpose of determining the effect of exposure to dust, the occupations were classified in four groups on the basis of these dust counts, as follows: Group A, hand pneumatic-tool cutters; group B, surface machine operators and cutters exposed to more than the average dustiness of the plants; group C, occupations in which the workers were exposed to the average dustiness of the plants (lumpers, bed setters, etc.); group D, occupations in which the workers were exposed to less than the average dustiness of the plants.

DESCRIPTION OF THE VERMONT GRANITE WORKERS

The granite cutters, on the whole, were of good physique; average height 66.9 inches, weight 157 lbs. They usually remained in the

industry all of their working life. Seventy-five percent of them had been employed in the industry for more than 10 years. Their wages were good and their living conditions were much above the average for industrial workers.

The minimum wage for granite cutters was \$1 an hour, or \$8 a day. Carvers, sandblasters, and other highly skilled workers received more. The polishers, cranemen, lumpers, and other less skilled workers received \$0.77 per hour. Incidentally, this group had a lower tuberculosis rate than the cutters, who received better wages. The working hours during the time of our observations were 8 hours a day, with a half day on Saturday.

Eighty-three percent of the workers in the granite industry comprised five racial groups: Italian (northern), Scotch, American, Spanish, and French-Canadian. The Italians who made up 33 percent of the group are from the northern provinces of Italy; many are from the Swiss border. The Scotch are principally from Aberdeen. The Americans are largely local New Englanders, and the Spanish are from the Province of Santander. (The racial groups have not changed materially since the original study.)

SICKNESS AND MORTALITY RECORDS

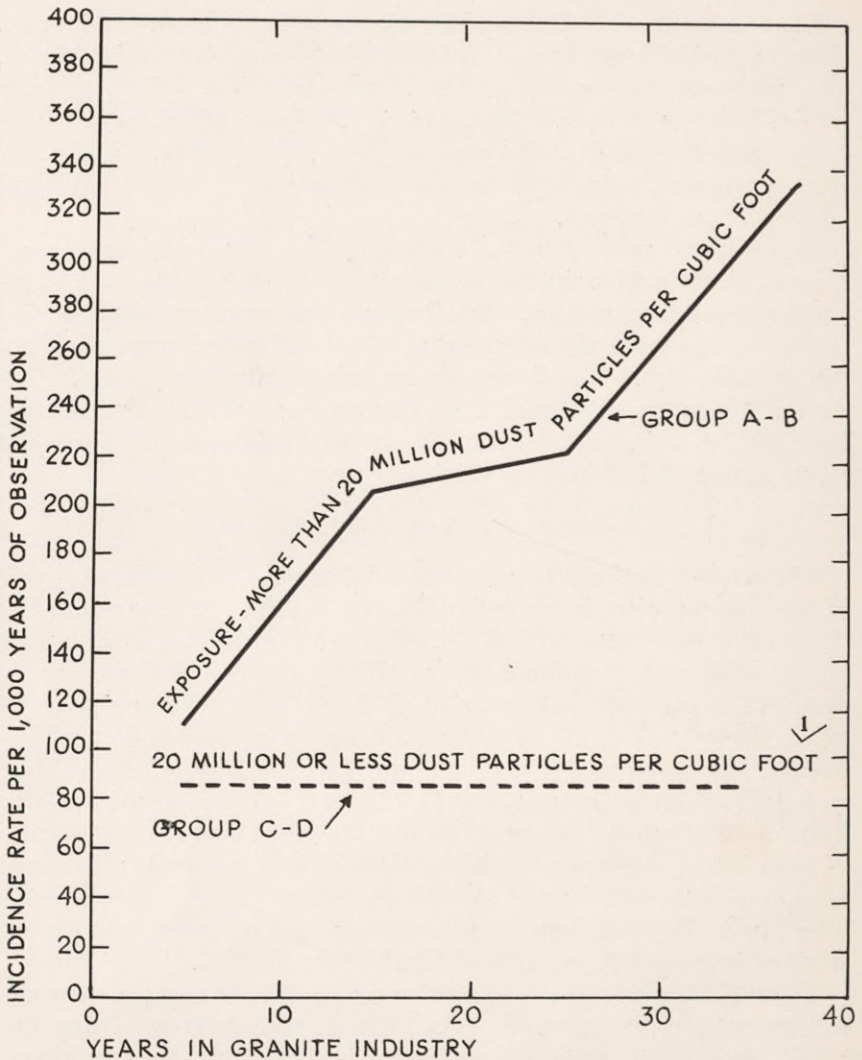
The relation between the general sickness records and the dustiness of each occupation is of particular significance. The incidence of illness from all causes (disabling for 8 days or longer) in groups A and B combined was about 215 per 1,000 years of observation; in group C, it was 105; and in group D it was 61. All respiratory illnesses showed a striking difference. When the sickness due to tuberculosis was eliminated from the total, the respiratory illness rates were still higher in groups A and B than in C and D, due primarily to influenza and colds. It seems obvious that the excessive dust hazard is reflected in the general sickness rates as well as in the prevalence of tuberculosis. Groups C and D seemed to have moderate rates. The rapid rise with length of service in the sickness rate among workers in groups A and B is brought out in figure 1.

The incidence of silicosis and tuberculosis did not seem to vary significantly according to race. The sickness records showed that disability from pulmonary conditions, experienced by these workers, varied in proportion to the length of service and extent of dust concentration.

The rate of sickness for all causes among those who subsequently developed tuberculosis was nearly three times as high as it was among those who did not develop the disease.

The percentage of cases of tuberculosis in the various dust-count groups is shown in figure 2. The contrast between the A-B groups

and the C-D groups is extremely significant. Group D furnished no cases and group C but three cases. The rise in incidence of the disease in group A-B with length of service is so unmistakable and so rapid



¹ Mean for all lengths of service. The data are too small to establish a reliable trend.

FIGURE 1.—INCIDENCE OF SICKNESS FROM ALL CAUSES BY LENGTH OF SERVICE AND DUST COUNT GROUPS.

that there can be no question but that it is associated with the dust hazard of the industry.

Figure 3 shows the increase in deaths from tuberculosis since the introduction of pneumatic tools. The rates for granite cutters are compared to those of males in rural Vermont and in the registration

area of the United States as of 1925. The differences point definitely to the dust hazard incident to the new method of cutting granite.

The annual tuberculosis death rate per thousand for dust count group A was found to be 19.5, and for group B, 12.8. In groups C

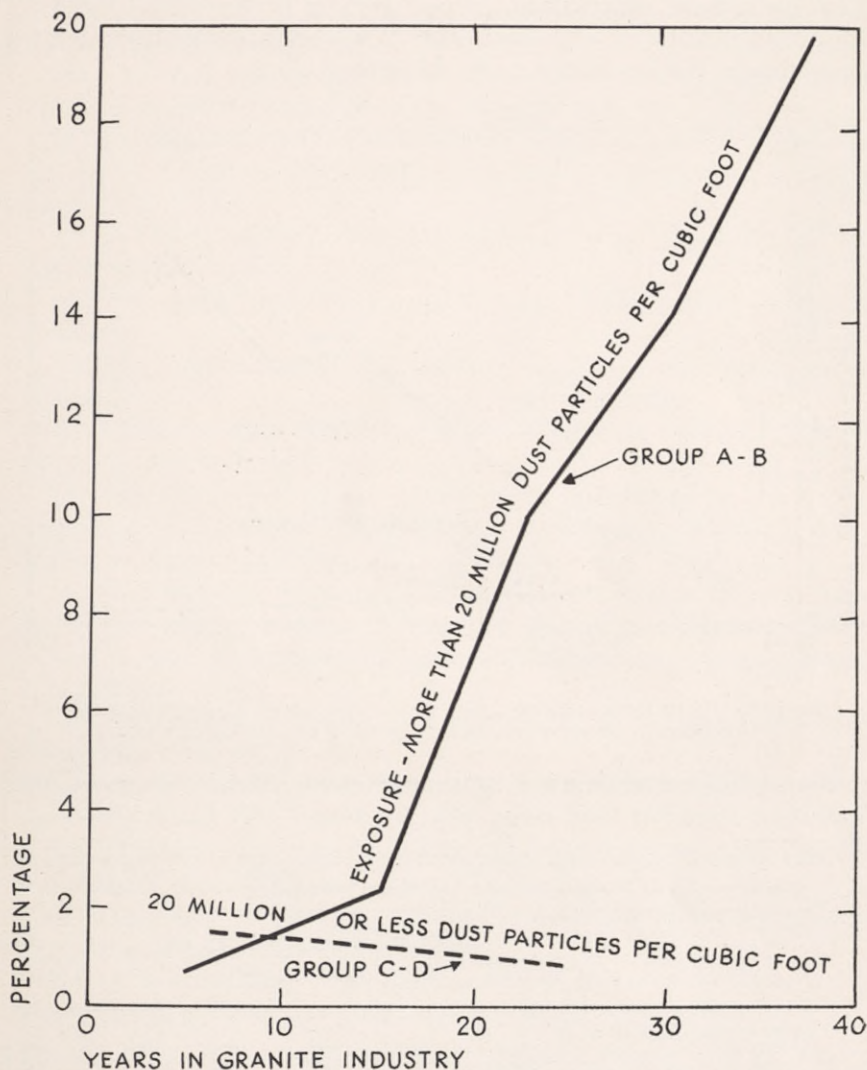


FIGURE 2.—PERCENTAGE OF WORKERS DIAGNOSED ON PHYSICAL EXAMINATION AS HAVING TUBERCULOSIS (ACTIVE).

and D only 1 death occurred (a rate of 1.2 per 1,000). When the two groups with the highest dust exposure are considered together, the death rate from tuberculosis per thousand was 26 for 20 to 24 years' exposure, 29 for 25 to 34 years' exposure and 47 for longer periods.

Although the mortality rates were found to be high, a word of warning was given in Public Health Bulletin 187 that even higher

rates should be expected. The present condition has developed since the introduction of hand-pneumatic tools for cutting granite. This change from the hand mallet and chisel began about 1894, hence the effect of the increased and intensive exposure to dust may not yet have been fully experienced. The lessening of the dust hazard by improved ventilation and local exhaust will eventually bring about a reduction in the death rate from tuberculosis.

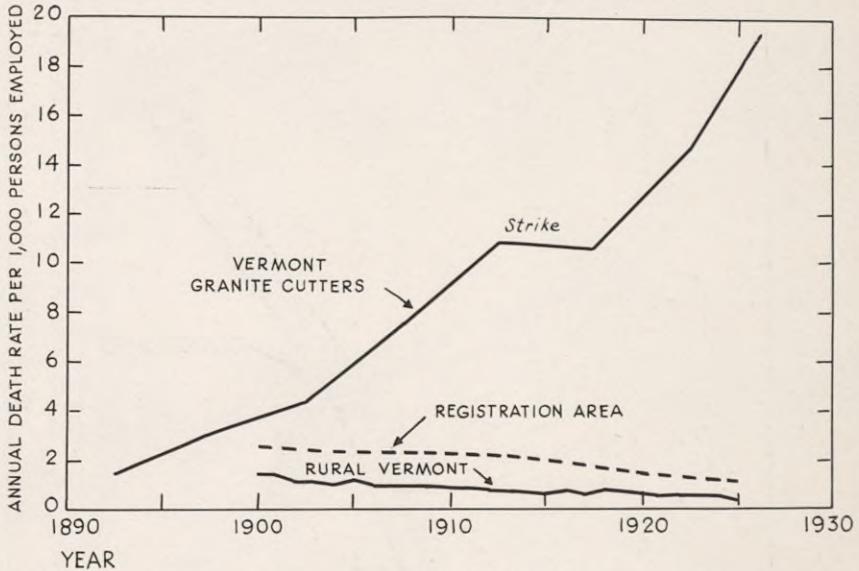


FIGURE 3.—INCREASE IN MORTALITY FROM PULMONARY TUBERCULOSIS SINCE INTRODUCTION OF PNEUMATIC TOOLS IN GRANITE CUTTING.

Since the introduction of pneumatic tools, the mortality among granite cutters has been rising year by year. (See fig. 3.)²

² Data for the period since the original Public Health Service study are summarized in the following table:

Data on mortality for Vermont, Washington County, and Barre City per thousand population, 1926-36

Death rates	Vermont	Vermont except Washington County	Washington County	Washington County except Barre City	Barre City	Barre granite plant workers
Death rate from all causes:						
1926-30	14.3	14.0	16.7	16.8	16.4	15.8
1931-35	13.6	13.5	14.8	14.8	14.7	23.5
Death rate from tuberculosis:						
1926-3061	.41	2.28	1.74	3.81	10.6
1931-3548	.30	1.84	1.31	3.24	16.8
Percentage of deaths due to tuberculosis:						
1926-30	4.3	2.9	13.6	10.4	23.2	66.6
1931-35	3.5	2.2	12.5	8.8	22.0	71.5
Population:						
1920 census	352,428	313,507	38,921	28,913	10,008	¹ 2,500
1930 census	351,061	309,789	41,272	29,967	11,305	¹ 2,000

¹ No actual figures available. Estimates based upon arbitrary figures. A survey in 1937 showed Barre City granite plant workers to number 1,533.

GENERAL COMMENTS ON SILICOSIS AND TUBERCULOSIS AMONG GRANITE WORKERS

The most important conclusion of the study has been a confirmation of the findings in the original study which pictured the results of exposure for many years to a dust of a known character. The significant features of the picture are:

(a) The long period of service before the liability to tuberculosis becomes manifest (generally about 20 years or more).

(b) The sharp correlation between the length of exposure to the dust and the prevalence of tuberculosis and also the death rate from this disease.

(c) The close relation between extent of dust exposure and the health of the workers.

(d) The universal occurrence of silicosis among workers in groups A and B.

(e) The large proportion of workers finally succumbing to tuberculosis.

(f) The invariably fatal form of the disease (tuberculosis) usually in a comparatively short time after it becomes a clinical entity.

(g) The different character of silicosis as manifested by the X-rays compared to that shown where there is exposure to a dust of a much higher content of free silica.

(h) The location of the initial tuberculous lesion, usually basal or in the middle portions, where the disease complicates silicosis. This is in contrast to the usual location of the lesions in uncomplicated tuberculosis.

(i) The absence of deaths from silicosis per se, tuberculosis almost invariably intervening.

(j) The failure of workers to recover from silicosis upon going into nondusty trades.

(k) The high incidence of sickness of a severe nature from causes other than tuberculosis.

(l) The rising sickness and mortality rates from tuberculosis due to the longer use of the pneumatic tools.

(m) The appallingly high death rates at the present time due to tuberculosis, compared with normal industrial experience.

CLINICAL AND X-RAY CHARACTERISTICS OF SILICOSIS AND TUBERCULOSIS IN GRANITE WORKERS

CLINICAL FINDINGS

It should be borne in mind that silicosis occurs in uncomplicated form as a simple silicosis and also with infection which is almost invariably tuberculous. The physical and clinical aspects of these two conditions are quite different in each instance. Since silicosis and tuberculosis may frequently co-exist, clinical considerations are important in diagnosis and prognosis. The general considerations briefly presented here are based on the experience of both the 1924-26 and 1937-38 studies. Uncomplicated silicosis is not accompanied by a general toxemia, which is in contrast to the findings when active tuberculosis is present. The patient with simple silicosis may be able to continue his work and usual routine without much inconvenience. He is usually found to be well nourished and apparently healthy until he is in the advanced stage of the disease.

Pathogenesis.—The dust enters the lungs in a downward direction and reaches the lower and middle portions before it becomes arrested on the moist walls of the bronchi and bronchioles. It has been stated that very little dust reaches the apical portions. The right bronchus is larger than the left and enters the lung at about a 24° angle, whereas the left, the smaller one, enters at an angle of about 45° , and the dust is more readily impinged against moist walls of the pulmonary structures before it reaches the bronchioles. It can be readily seen that there is a good reason for more pathologic changes in the right lung. Incidentally, there were more early tuberculous lesions found in the right lung than in the left.

As the condition advanced, there occurred more dense shadows due to the coalescence of the silicotic nodules and the increasing density of the fibrosis. There were evidences of irregularities of the contour of the diaphragm due to pleural thickening and adhesions. There was found dense pleurae in all the cases that came to autopsy.

The workers in dust count groups A and B, in practically all cases, did not show any evidence of silicosis on physical examination until after 15 years of dust exposure. Those workers who were exposed to less amounts of dust, groups C and D, did not show evidence of the disease until after a much longer period of exposure. The diagnosis in all these cases was made on history of exposure, physical examina-

tion, and, where possible, by X-ray. In the more advanced cases, the symptoms were more evident.

Dyspnea is usually the first complaint and is quite constant in silicosis, increasing in severity with length of exposure. In the granite workers, the dyspnea continued to increase even after cessation of exposure once silicosis was well established. Pains in the chest were a common complaint. Granite cutters with uncomplicated silicosis usually have a nonproductive cough which seems to cause them no inconvenience. They have frequent colds.

PHYSICAL EXAMINATIONS

Physical examination will reveal some limitation of chest expansion usually in proportion to the extent of exposure. The restriction of expansion is symmetrical in contradistinction to the asymmetry found in tuberculosis uncomplicated by silicosis.

Physical examination usually reveals a general impairment of resonance over the chest, the intensity varying with the length of dust exposure. This finding is consistent with the character of the generalized fibrosis of the lungs in silicosis. The fibrosis of tuberculosis is localized over the infected area, whereas the fibrosis of silicosis is generalized. It may be easy to overlook the presence of impaired resonance since it is generalized and there are no local areas to afford a contrast in the percussion note as is the case in tuberculosis and pneumonia.

The breath sounds are found to be soft which accentuates the vesicular type of breathing. Riddell³ states that "The commonest change is in intensity. Breath sounds in silicosis tend to be distant or blanketed." Rales are absent in uncomplicated cases. The intensity of signs discovered on physical and X-ray examination are usually found to be in direct proportion to the length of dust exposure.

X-RAY FINDINGS

When the pathology of uncomplicated silicosis is considered, it can be seen that with dust deposited in the lymphatic channels and nodes and along the bronchi and in the hilus the pulmonary changes indicated on the X-ray will be of a generalized nature. The body response to silica dust is the formation of fibrous tissue which is indicated on the X-ray by lineations which show nodulations in their course. This characteristic is more prominent as the condition becomes established. There is a predominance of shadows in the lower and middle portions of the lungs, with more on the right than the left in uncomplicated cases. As the condition progresses, there is an increase in the number and size of the nodulations and later these coalesce and

³ Riddell, A. R.: Clinical and Radiological Aspects of Silicosis. Canadian Public Health Journal, February, 1936, Vol. 27, No. 2.

thereby produce more dense shadows on the X-ray. The process of development of fibrosis is indicated by areas of consolidation in the more advanced cases. There is usually some evidence of pleural changes as indicated by irregularities of the diaphragm and the presence of a thickening of the interlobar pleura which usually appears as a line across the field of the right lung. Most of the advanced cases presented evidence of pleural changes.

When active tuberculosis becomes a complication of silicosis in granite workers, there are certain changes in symptoms and physical findings which usually make it easy to recognize the superimposed infection. Workers usually continue at their employment up to this time; however, they seem to have minor illnesses and lost time from work immediately preceding the onset of clinically active disease. These illnesses were reported on the morbidity records as suspected pulmonary tuberculosis in many cases, and no doubt were due to early manifestations of the superimposed infection. The reasons usually given were fatigue, pains in the chest, or the worker would say he needed a little rest. These symptoms usually aroused great fear on the part of the patient and his family. As the condition progressed, there was invariably a history of greatly increased dyspnea, increase in cough with the production of sputum, marked fatigue, hemoptysis, and in some cases frank hemorrhages. There were pains in the chest usually of an acute nature, in some instances so severe as to require opiates.

These patients have a great fear of tuberculosis and usually refrain from complaining of symptoms referable to the chest, and in many instances it was necessary to obtain the history from members of the family. Patients in some instances denied hemoptysis yet members of the family reported hemorrhages from the lungs. A history of pulmonary hemorrhage was often the earliest manifestation of clinical tuberculosis. Other complaints that were elicited in the early cases were fever, night sweats, loss of weight and strength, and pains in the chest. As the tuberculous infection advanced, there was no great difference in the clinical evidence of tuberculosis in these workers and that found in the fulminating type of the disease in nonsilicotic persons. It was usually easy to find tubercle bacilli in the sputum.

The physical signs of tuberculosis complicating silicosis where a general pulmonary fibrosis already exists present variations from those which are found in uncomplicated cases. When consolidation and cavitation occur, the signs are similar to the usual case of tuberculosis. The latent or *post tussic* rales are constant and not unlike the same valuable diagnostic sign in uncomplicated tuberculosis.

The X-ray characteristics of silicosis and tuberculosis are demonstrated in the X-ray reproductions which are presented subsequently, especially in the ones from the cases observed in 1937 and 1938.

COMPARISON OF FINDINGS ON PERSONS EXAMINED IN 1924-26 AND AGAIN IN 1937-38

The granite industry in the United States originally began in Vermont and has been carried on there for more than 125 years. The workers are men of stable character, substantial citizens, and usually remain on the job throughout their lives. The hazard to their health because of the nature of their work is of particular interest to physicians, industrialists, workmen compensation commissioners, and jurists. The effects of silicosis and its association with tuberculosis are of paramount interest. The opportunity for studying the rate of progress of silicosis in this country has been rare. It has been hindered because of the chronic nature of the condition, its slow development and the small number of workers available in a particular locality where they might be observed over a period of years. Because of excellent relationships which existed between the Public Health Service and the workers, manufacturers, unions, physicians, hospitals, and State health department in Vermont during the original study, it was possible to make supplementary observations of the progress of silicosis among the granite workers.

Physicians in South Africa, where gold mining is the principal industry in which silicosis is a hazard, have been able to follow their cases and have contributed most of what we know about the progress of silicosis. The type of native workers, their living conditions, and the high percentage of silica in the dust are factors which vary greatly from that of the granite industry in Vermont. All of the workers in granite are white people and have excellent living conditions.

When these factors are considered it can be seen readily that the progress and outcome of the disease would also be different. Incidentally, in the United States there are so many dusty trades in which the extent and nature of dust exposure is quite varied that the results in one industry are not always comparable to those in another. It was not possible to classify the stages of silicosis found among the granite workers by the classification which was in use in South Africa and largely employed in this country at the time of the publication of Bulletin No. 187. The classification of the stages of silicosis in South Africa was made as the scientific facts about silicosis were emerging and were written into the laws of that country and for that reason they have not been changed. The silicosis in granite workers is quite different from that which is found in the South African gold

miners as well as from cases in this country with exposure to dust of different concentration and silica content.

The observations on the granite workers were started early in 1937 and finished in 1938. The objective was to reexamine as many of the former workers as possible and to account for those who had died or moved away. Excellent cooperation with the State board of health and the physicians of Barre was obtained. Offices were established at the Barre City Hospital and arrangements were made to use the hospital X-ray equipment for making the X-rays. The examinations and X-rays were made by the author and Dr. L. E. Judd of the division of industrial hygiene of the State board of health. A number of granite cutters who were not in the original study were also examined; however, they are not included in this report.

It was possible to make observations on a group of granite workers who had continued in their original occupations and whose dust exposure had remained essentially the same since the period of the original Public Health Service study. They had not worked as regularly as they did prior to the time of the industrial depression; however, most of them had been able to work at intervals. Their exposure to dust was lessened somewhat by the smaller amount of work; however, the dustiness of their particular occupations remained practically unchanged.⁴ The workers classed according to dust exposure as groups A and B in the original study are considered first, and those in groups C and D later in the report.

Brief case histories are presented with the old X-rays. It was not possible to get X-rays on all the workers during the first study, and many of those who were found to be essentially negative on physical examination were not examined by X-ray. Some of these cases are presented after the group on whom there are X-rays from both studies.

The progress of silicosis in the cases presented has not been at the same rate although the dust exposure has been about the same. Study of the cases and their X-rays seems to indicate that the presence of infection, which is almost invariably tuberculosis, is the main factor in the difference in the rate of development of the condition. In the previous study, a number of cases of silicosis apparently without latent tuberculous infection were found. This group seems to have had slower progress than others with evidence of infection. It should be kept in mind that it is not always possible to distinguish between the fibrosis of silicosis in the early stages and that of tuberculosis.

Diagnosis of silicosis should not be made by the X-ray alone. However, it is the most valuable procedure in diagnosis and should always be employed. X-ray characteristics of silicosis are so pro-

⁴ Ventilation in the Granite Industry. Edward C. J. Urban, J. of Ind. Hyg. & Toxicol. 21: 3, (Mar.) 1939

nounced that it may easily become a habit to omit other procedures in the diagnosis. The physical examination and history of occupational life is also very important and should not be overlooked. Asbestosis, mycotic infections, miliary tuberculosis, tuberculous broncho-pneumonia, passive congestion of the lung, and bilateral bronchiectasis are conditions which may give X-ray characteristics similar to silicosis. Certain metastatic malignant conditions of the lung may give X-ray markings suggestive of silicosis. Occasionally X-rays of silicosis will show deviations from the usual picture. This emphasizes the importance of accounting for the whole occupational life of the worker with detailed information relative to occupations which entail dust exposure.

In the following discussion of the findings on men who were examined in 1924-26 and again in 1937-38, a distinction has been made between (1) granite cutters (groups A and B) who continued at their trades, (2) granite cutters who changed to nondusty occupations, and (3) those who were in the low exposure groups (groups C and D) at the time of the original study.

GRANITE CUTTERS, GROUPS A AND B, WHO CONTINUED AT OCCUPATION

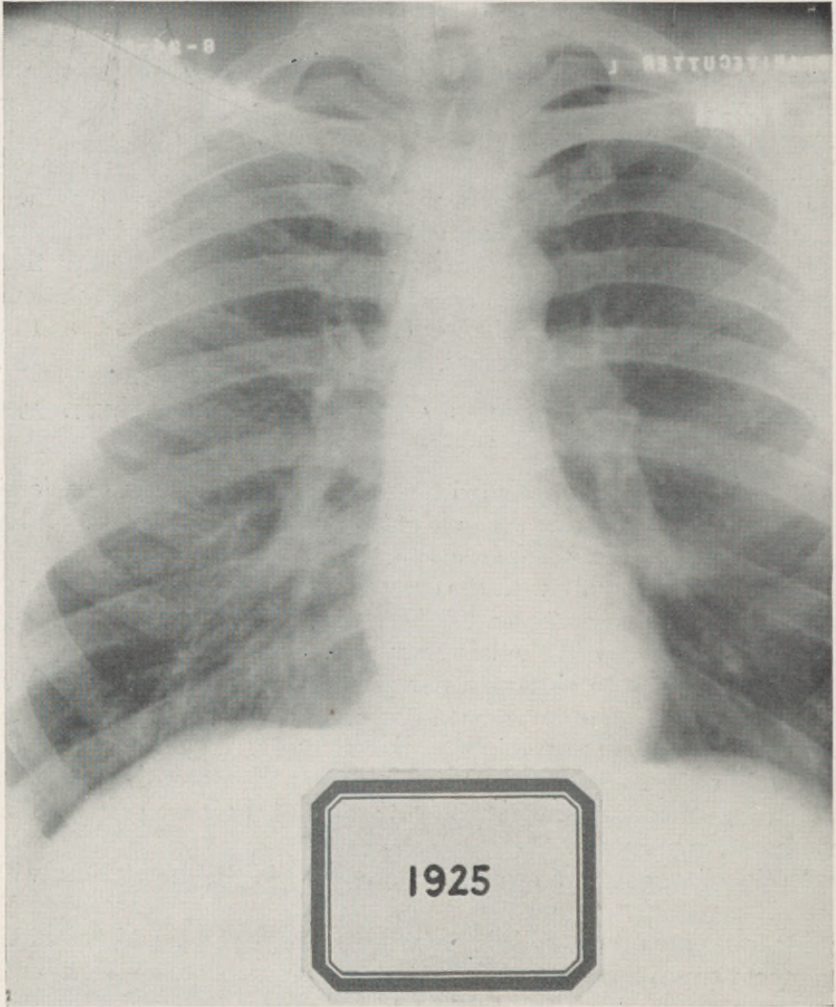
A group of cases is presented here to show the progress of silicosis that has taken place since the time of the original observations. It has been stated that their occupations are the same as they were during the period of original study with the exception that the amount of work to which they were accustomed has been less, owing to economic conditions of the country in the last few years.

It was possible to observe a few granite cutters in 1931, at which time a dust study of quarrymen in Barre was being made. These same workers had been observed in the original study. It was also possible to obtain a few X-rays of these patients from the Barre City Hospital which were made subsequent to 1931; some of these are presented for comparative purposes.

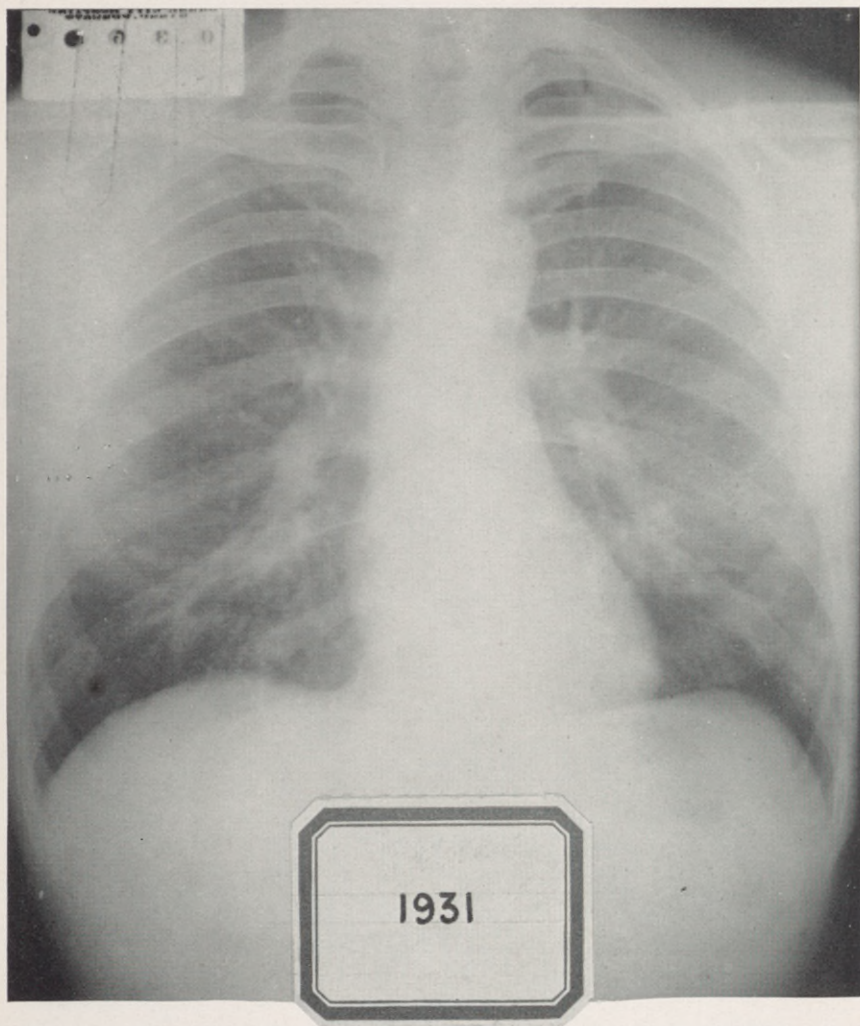
Nationality, age, and occupation are given in the descriptions with each X-ray print.

Histories are presented briefly with the X-ray prints and very little comment seems necessary inasmuch as the progress of the condition is quite apparent. The first case illustrated, plates 1, 2, and 3, is interesting because of the patient's exemplary habits and strict routine of living. He had no complaints at any time during the earlier observations except shortness of breath on exertion. In 1937 he complained of pleurisy pains and a susceptibility to colds. From the appearance of the 1937 and 1938 X-rays, it seems that a tuberculous complication might intervene at almost any time.

PLATE NO. 1.

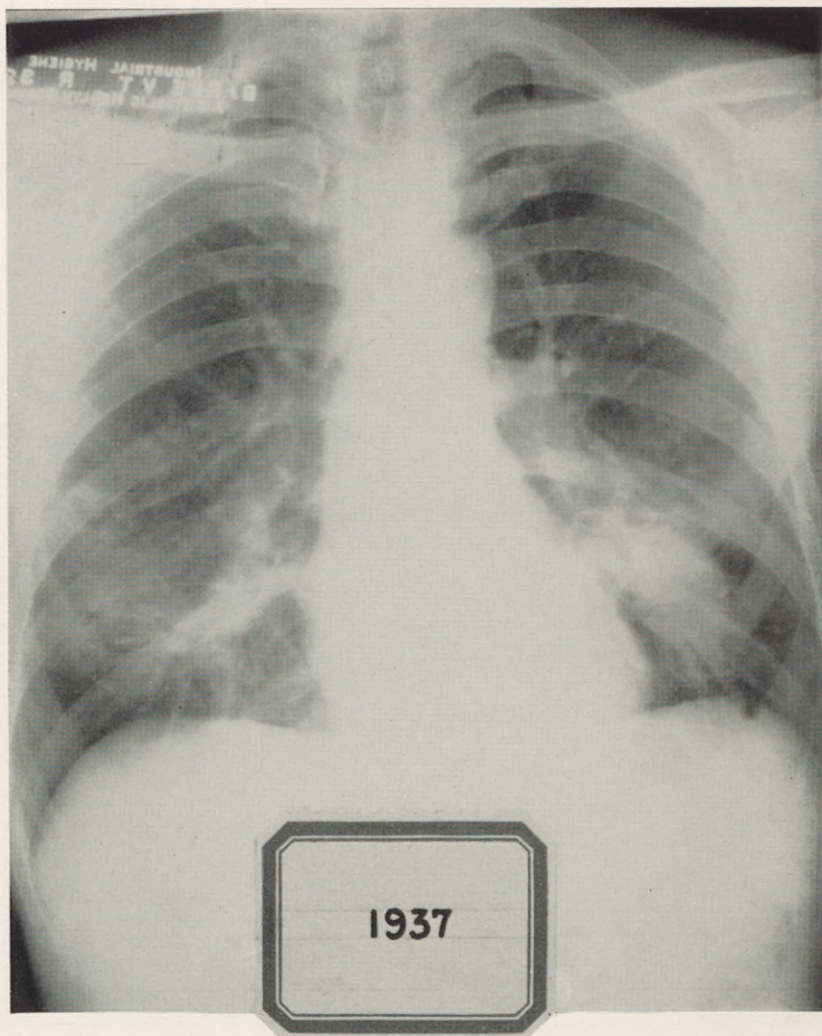


CASE 32. J. M. EXAMINED 1925. SCOTCHMAN. AGE 40. GRANITE CUTTER, SURFACE MACHINE OPERATOR 21 YEARS. FATHER DIED OF TUBERCULOSIS AT AGE 62; HE WAS ALSO A GRANITE CUTTER. PATIENT COMPLAINS OF DYSPNEA; OTHERWISE HE ENJOYS GOOD HEALTH. X-RAY SHOWS EARLY SILICOSIS.



CASE 32. J. M. EXAMINED AUGUST 1931. NO COMPLAINTS EXCEPT
DYSPNEA ON EXERTION. NO EVIDENCE OF CLINICAL TUBERCULOSIS.

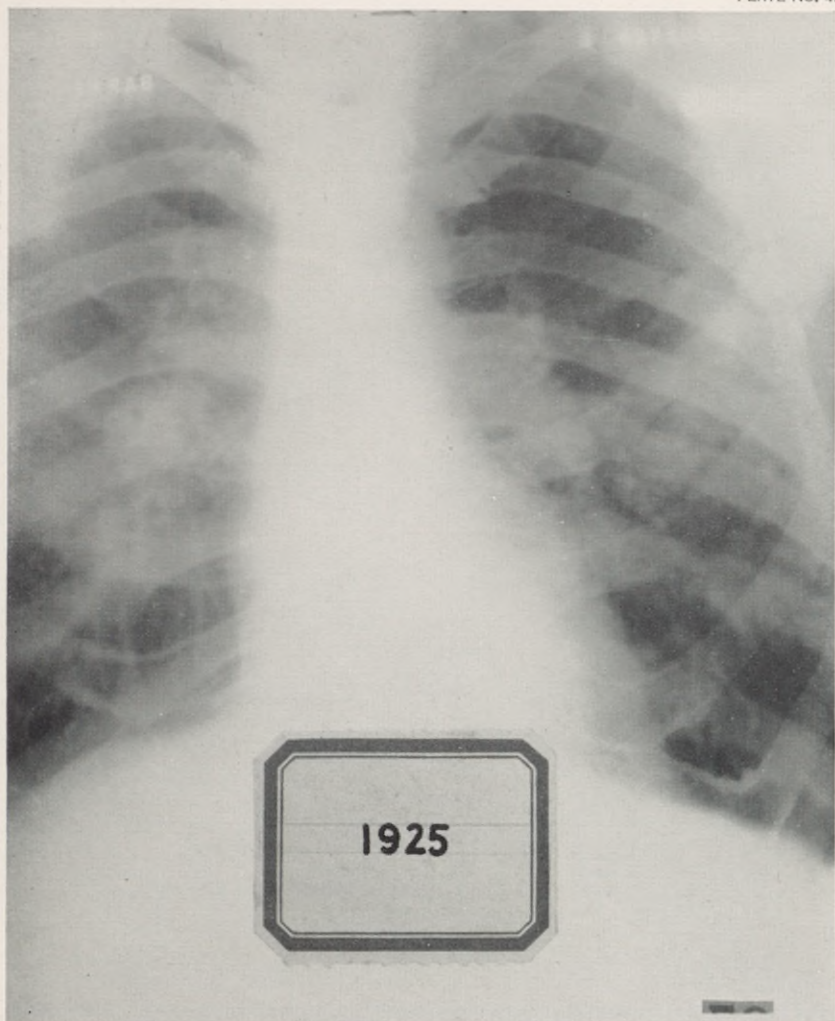
PLATE No. 3.



CASE 32. J. M. EXAMINED APRIL 23, 1937. AGE 52, WEIGHT 145 POUNDS. HAS CONTINUED TO CUT GRANITE EXCEPT FOR BRIEF PERIODS SINCE PREVIOUS EXAMINATION. COMPLAINS OF DYSPNEA. ADVANCED SILICOSIS.

The case illustrated in plates 4 and 5, case 99 (A-B group), demonstrates that the onset of tuberculosis in this group of silicotic patients cannot be easily foretold by the X-ray. The shadows in the right hilus of 1925 X-ray seem to indicate a beginning tuberculosis (fourth rib near and at periphery, left). This is even more striking in the

PLATE NO. 4.

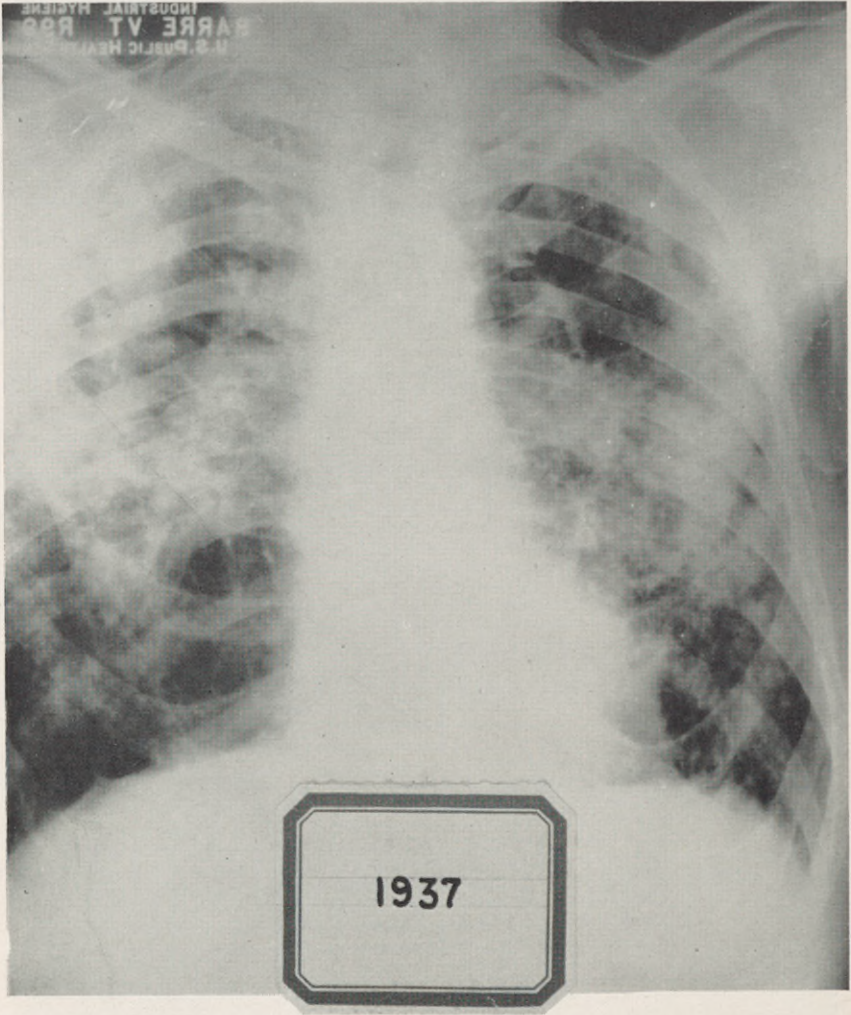


CASE 99. R. C. EXAMINED JUNE 1, 1925. ITALIAN. AGE 53. HEIGHT 69 INCHES. WEIGHT 178 POUNDS. GRANITE CUTTER 35 YEARS. MODERATE SILICOSIS.

NOTE (1940).—PATIENT HAS DEVELOPED OPEN TUBERCULOSIS.

1937 X-ray. The character of the markings is such that it seems almost certain to be tuberculous; however, it was not possible to demonstrate any evidence of it on physical examination. This man has continued to work and at present is in good health except for dyspnea.

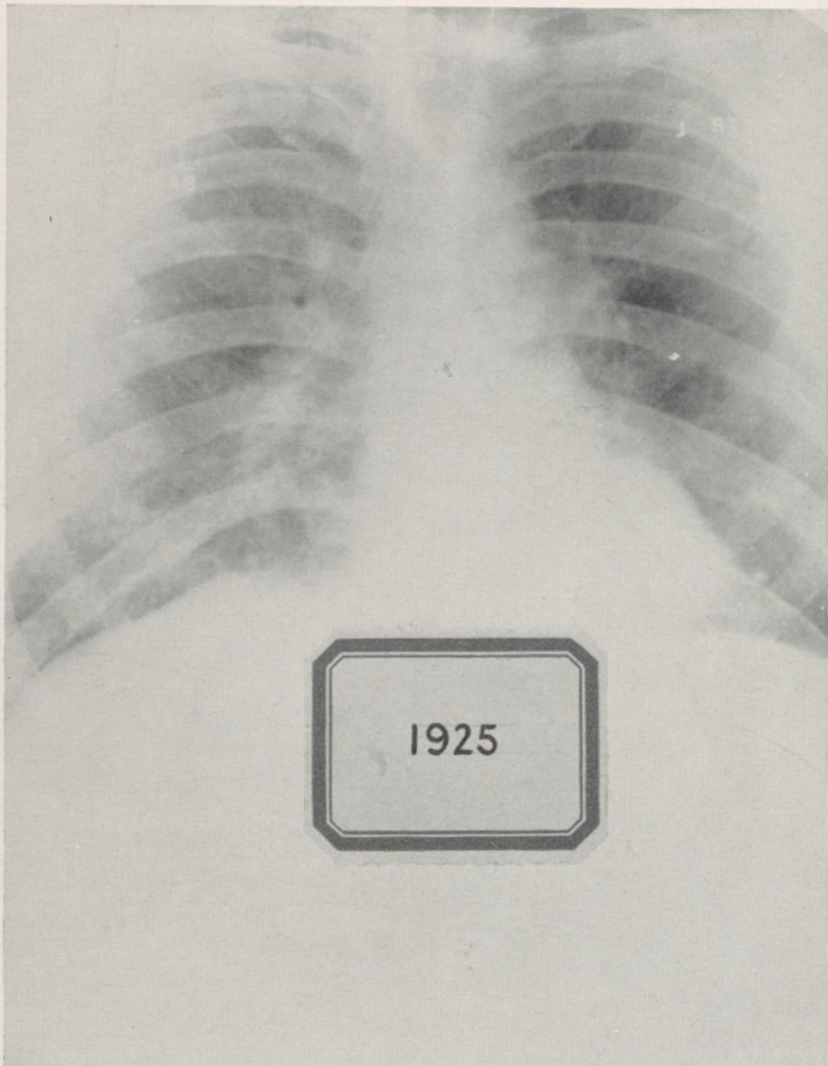
PLATE NO. 5.



CASE 99. R. C. EXAMINED MAY 29, 1937. AGE 65. WEIGHT 166 POUNDS. HE HAS CONTINUED TO CUT GRANITE SINCE PREVIOUS EXAMINATION EXCEPT FOR SHORT INTERVALS. COMPLAINS OF DYSPNEA ON SLIGHT EXERTION. CHEST SHOWS EVIDENCE OF ADVANCED SILICOSIS.

Case 186 (A-B group), plates 6 and 7, showed a fine linear type of fibrosis in 1925. He has continued at his old occupation since that

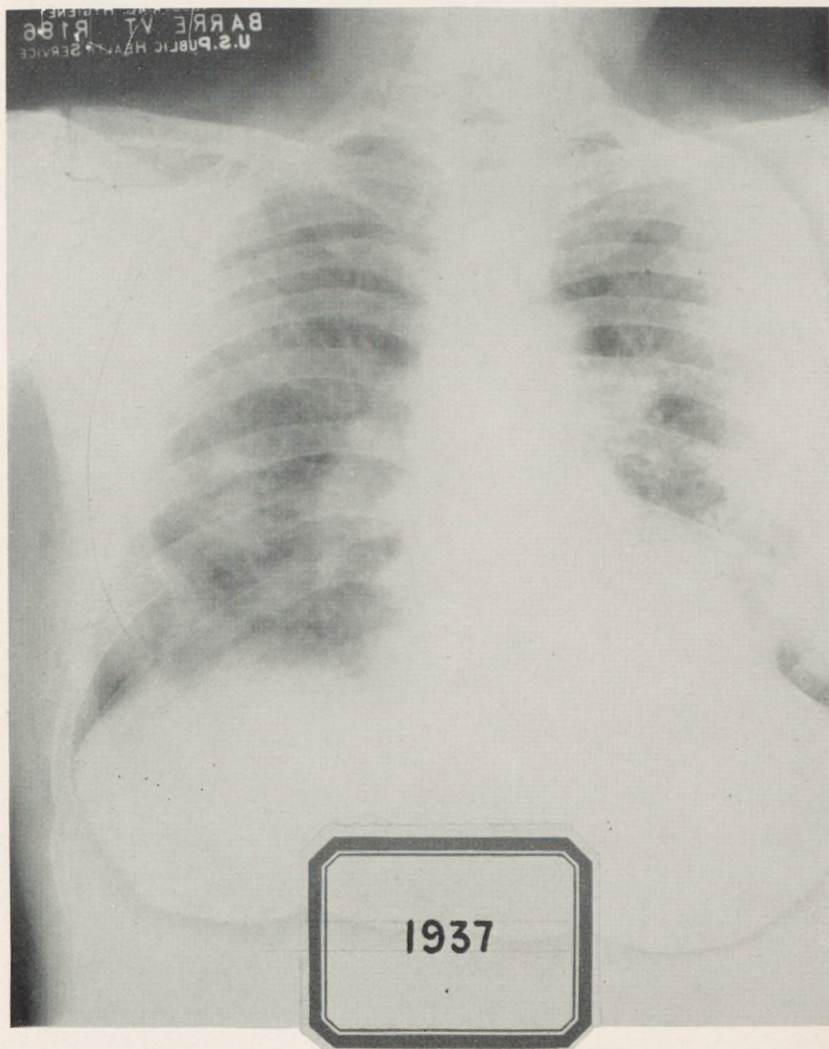
PLATE NO. 6.



CASE 186. J. S. EXAMINED JANUARY 5, 1925. FINN. AGE 42. HEIGHT 65 INCHES. WEIGHT 165 POUNDS. GRANITE CUTTER 23 YEARS. MODERATE SILICOSIS. X-RAY NO. 45.

time and in 1937 his X-ray still has some of the linear fibrosis; however, there is a tendency to a confluence of the shadows which have increased in density since the time of the original X-ray.

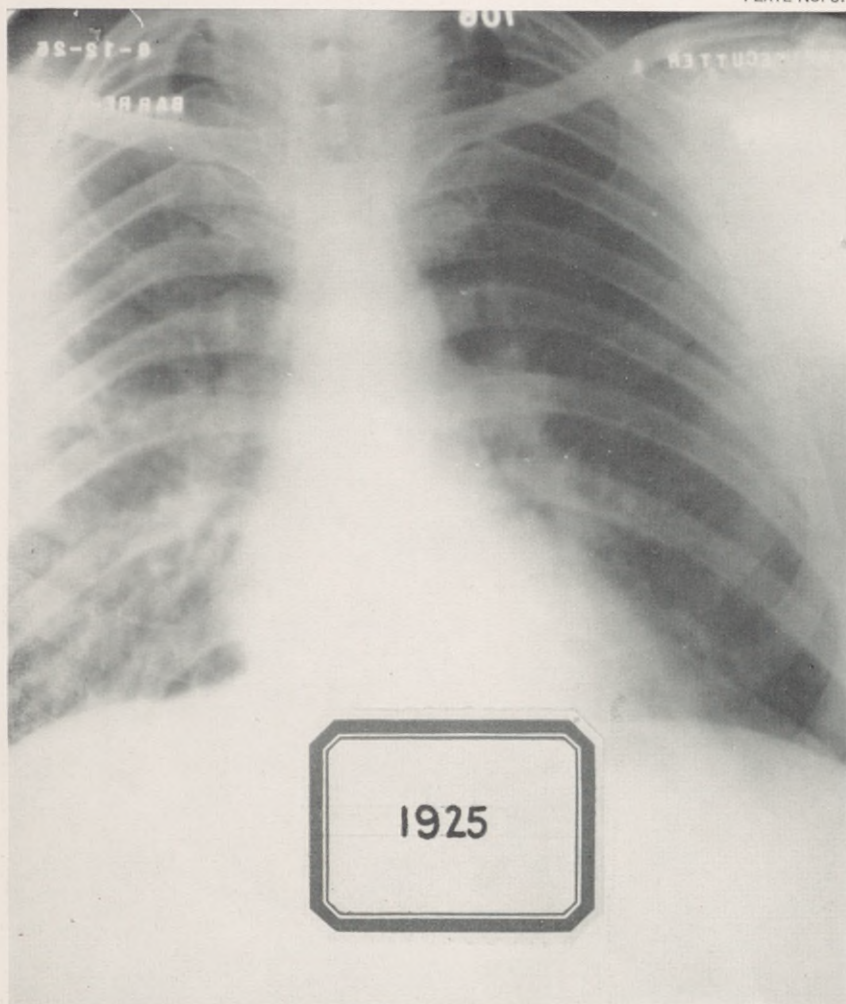
PLATE No. 7.



CASE 186. J. S. EXAMINED JUNE 25, 1937. AGE 55, WEIGHT 166 POUNDS. HE HAS CONTINUED TO CUT GRANITE SINCE PREVIOUS EXAMINATION. ADVANCED SILICOSIS.

Plates 8, 9, and 10, case 11, show only a moderate amount of silicosis in the X-rays of 1925 and 1931. The changes indicated in the 1937 X-ray are such that it is not possible to make a diagnosis of

PLATE NO. 8.

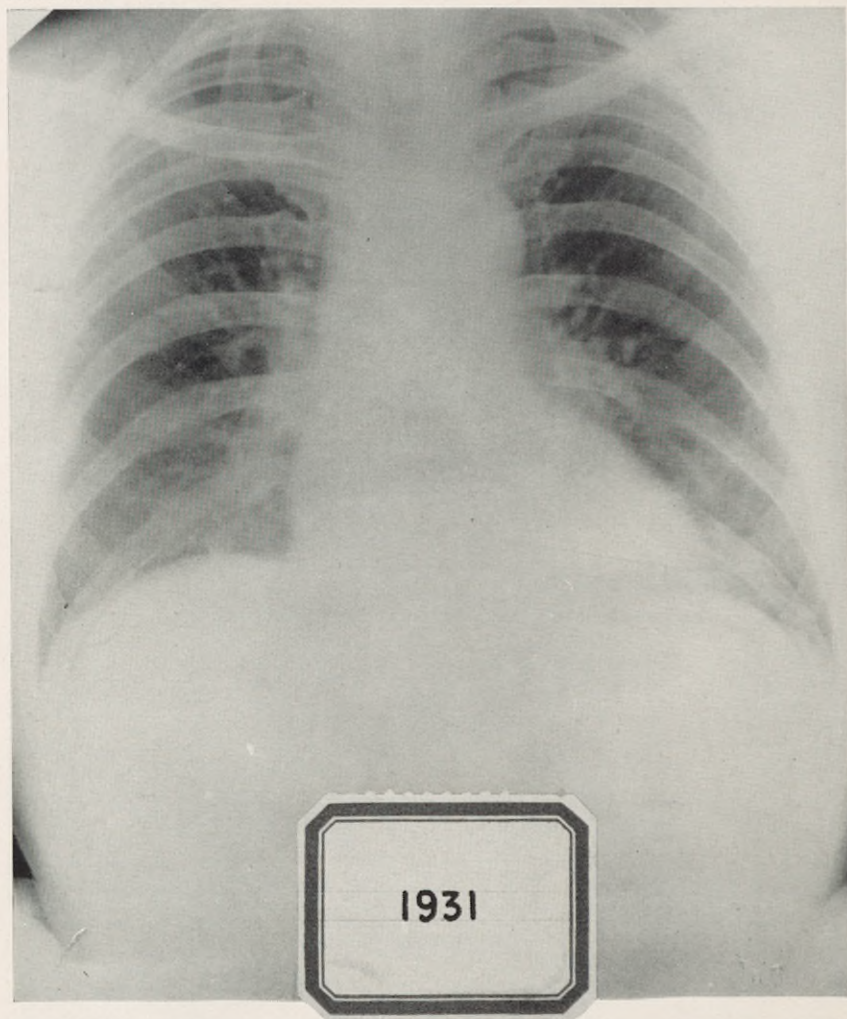


CASE 11. J. J. EXAMINED JUNE 11, 1925. HEIGHT 73 INCHES, WEIGHT 188 POUNDS. AGE 44, SWEDISH. HAS CUT GRANITE 27 YEARS, 13 OF WHICH HAS BEEN IN THE UNITED STATES, WHERE HE USED PNEUMATIC TOOLS. CHEST SHOWS EARLY SILICOSIS. X-RAY NO. 106.

tuberculosis from the X-ray. Physical examination, however, showed evidence of rales in the middle portion of the right lung and he had evidence of toxemia at that time. The late Professor Kettle pointed out that in his opinion the reason why silicotic patients

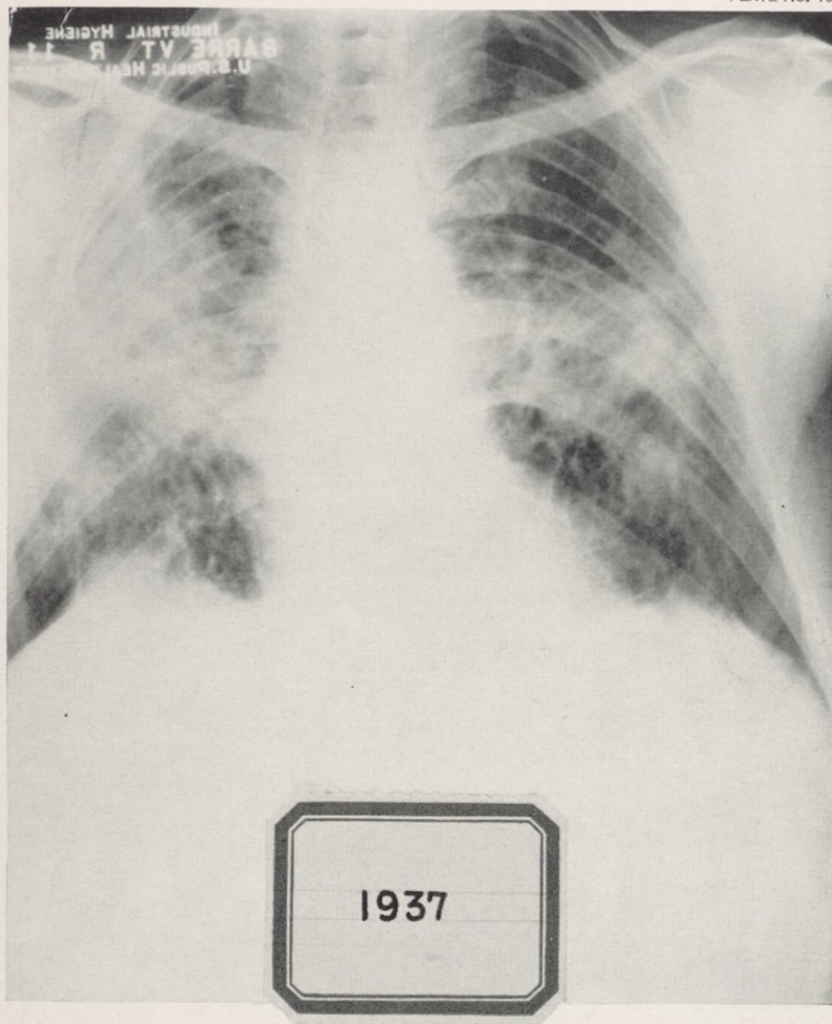
develop tuberculosis is not because of the damage produced in the lymphatic system but because of the presence of silica in the pulmonary tissue. This statement seems to carry more weight when

PLATE NO. 9.



CASE 11. J. J. X-RAY WAS MADE IN AUGUST 1931. THERE HAS BEEN AN INCREASE IN FIBROSIS BUT NOT TO A MARKED DEGREE. THE HEART SHADOW HAS NOT CHANGED APPRECIABLY. HE WAS IN GOOD HEALTH AND COMPLAINED OF DYSPNEA ONLY ON EXERTION.

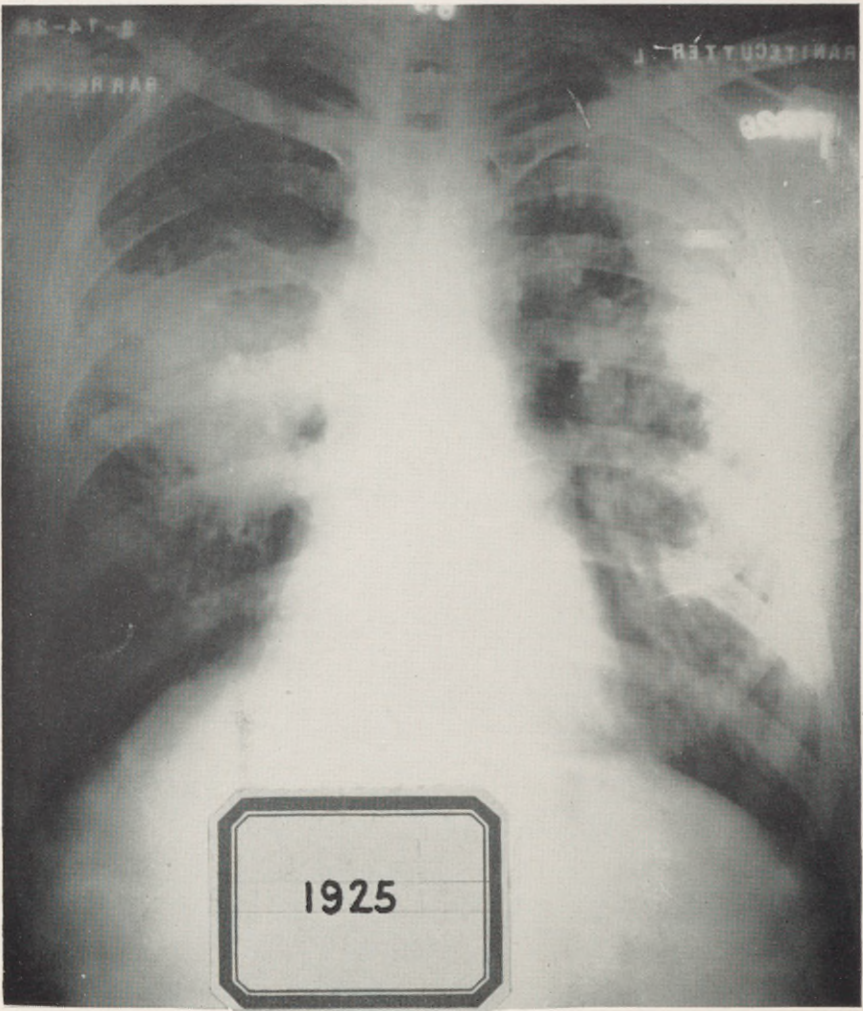
this case is considered and compared to the one that follows in which so much pathologic change is shown in the 1925 X-ray and the unusual amount in the 1931 X-ray. There was no evidence of clinical tuberculosis in the patient at the time these two X-rays were made.



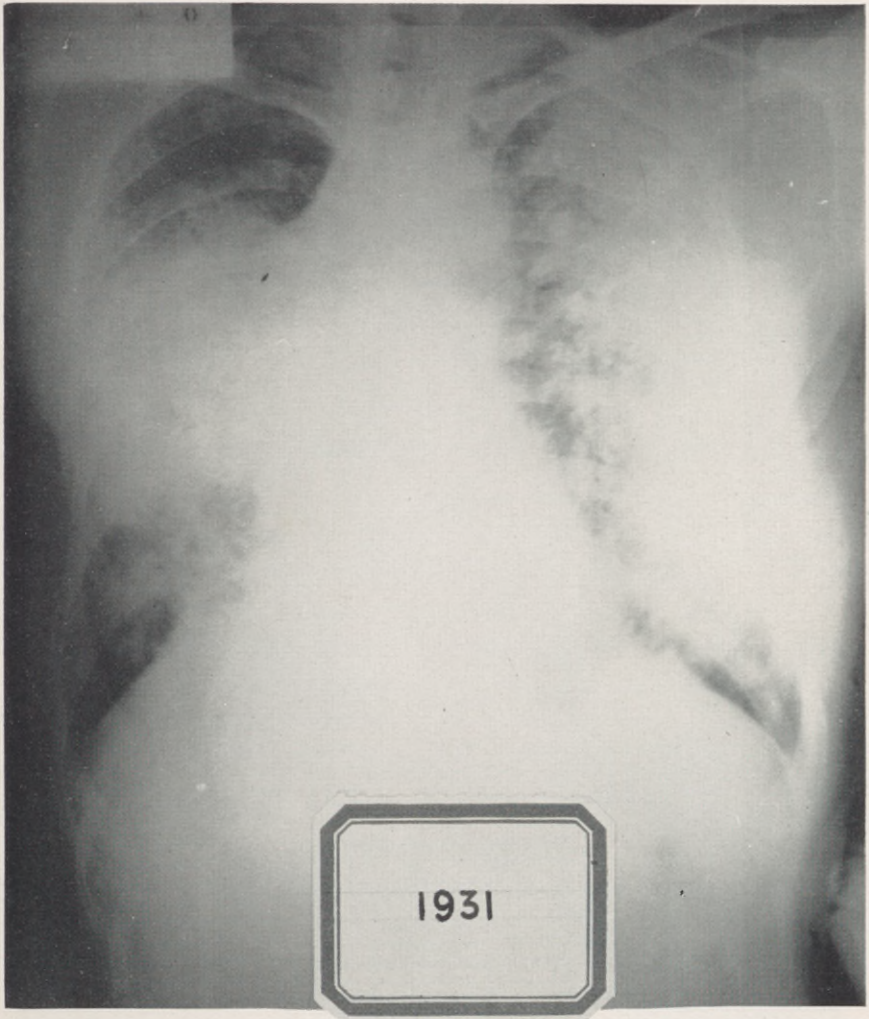
CASE 11. J. J. EXAMINED MARCH 26, 1937. AGE 56, WEIGHT 171 POUNDS. FOR THE PAST 5 YEARS HE HAS BEEN WORKING AS A BULL-SET HOLDER AND HAS HAD A RELATIVELY LOW AMOUNT OF DUST EXPOSURE. HAS NOT WORKED SINCE JANUARY 1937. COMPLAINS OF WEAKNESS, DYSPNEA, AND DEAFNESS. CHEST SHOWS EVIDENCE OF SILICOSIS AND TUBERCULOSIS. THERE HAS BEEN A CHANGE IN THE HEART SHADOW AND THE DIAPHRAGM.

NOTE.—PATIENT DIED IN FEBRUARY 1938.

PLATE NO. 11.



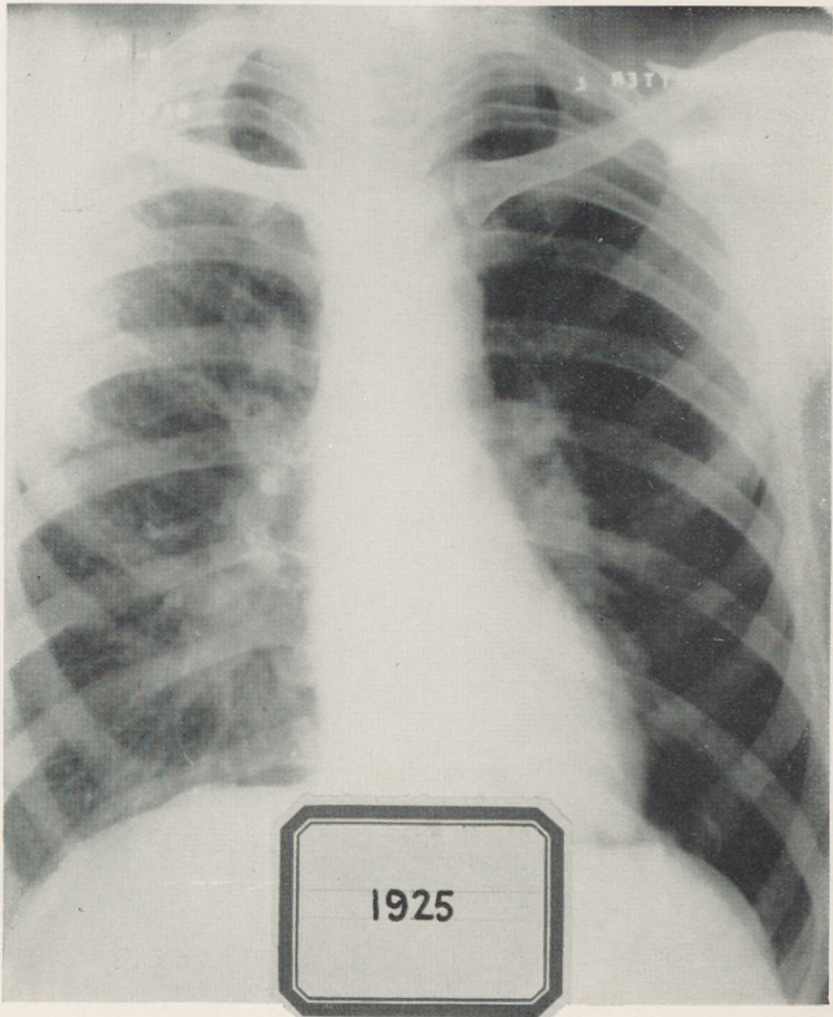
CASE —. C. G. EXAMINED 1925. FRENCH-CANADIAN DESCENT. AGE 48. GRANITE CUTTER FOR 29 YEARS, USING A HAND-PNEUMATIC TOOL. HEALTH GENERALLY GOOD AND THERE WAS NO MORBIDITY DURING THE PERIOD OF OBSERVATION. HEIGHT 68 INCHES. WEIGHT 161 POUNDS. PHYSICAL EXAMINATION REVEALED EVIDENCE OF ADVANCED SILICOSIS.



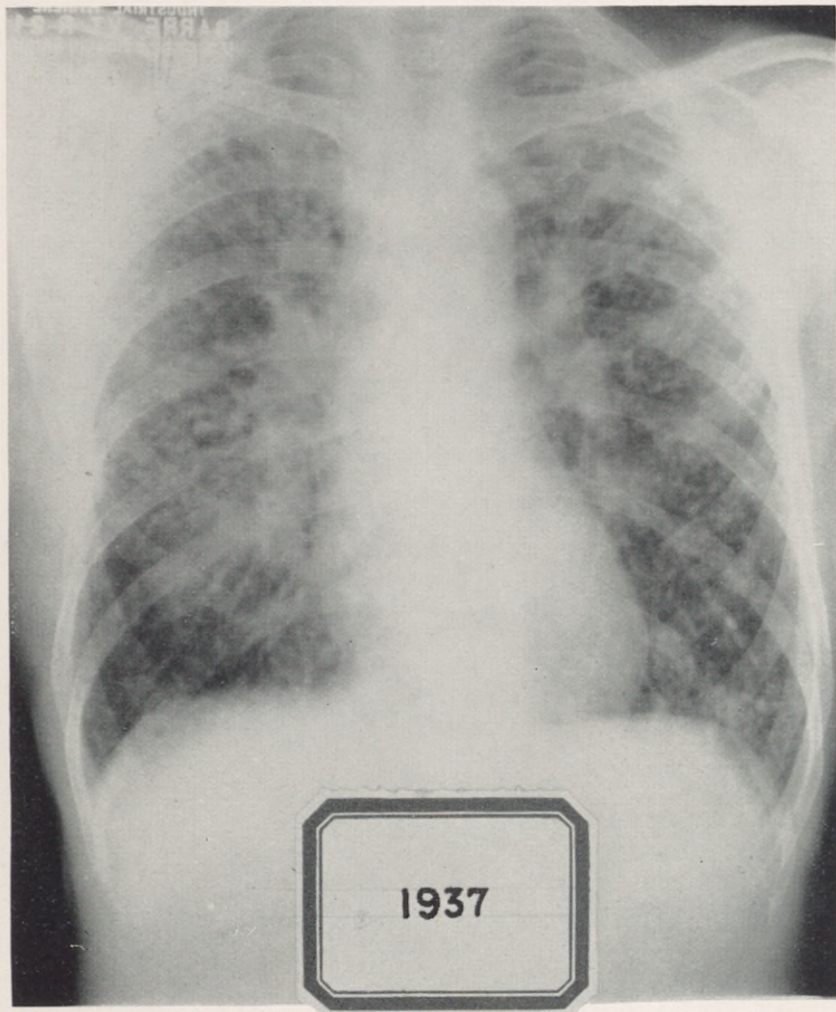
CASE —. C. G. EXAMINED AUGUST 1931. AGE 54. PATIENT COMPLAINS OF EXTREME DYSPNEA. PHYSICAL EXAMINATION REVEALS EVIDENCE OF ADVANCED SILICOSIS. NO RALES WERE EVIDENT AND PATIENT HAD NO SIGNS OF A TOXEMIA. DYSPNEA WAS SO SEVERE THAT IT WAS DISABLING.

NOTE.—PATIENT DIED OF TUBERCULOSIS IN 1931.

PLATE NO. 13.



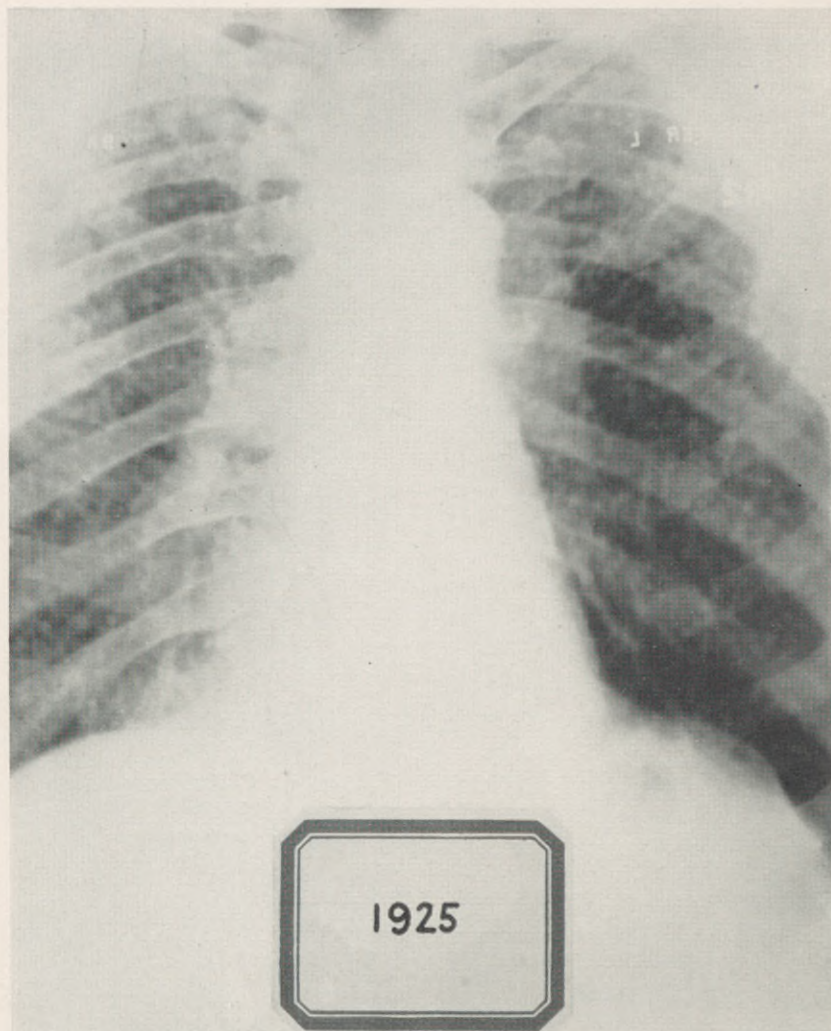
CASE 219. J. M. EXAMINED MARCH 12, 1925. SCOTCHMAN. AGE 47.
HEIGHT 68 INCHES, WEIGHT 142 POUNDS. GRANITE CUTTER (SURFACE
MACHINE OPERATOR) 22 YEARS. EARLY SILICOSIS. X-RAY NO. 84.



CASE 219. J. M. EXAMINED JULY 19, 1937. AGE 59, WEIGHT 129 POUNDS
HE HAS CONTINUED TO CUT GRANITE SINCE PREVIOUS EXAMINATION.
ADVANCED SILICOSIS.

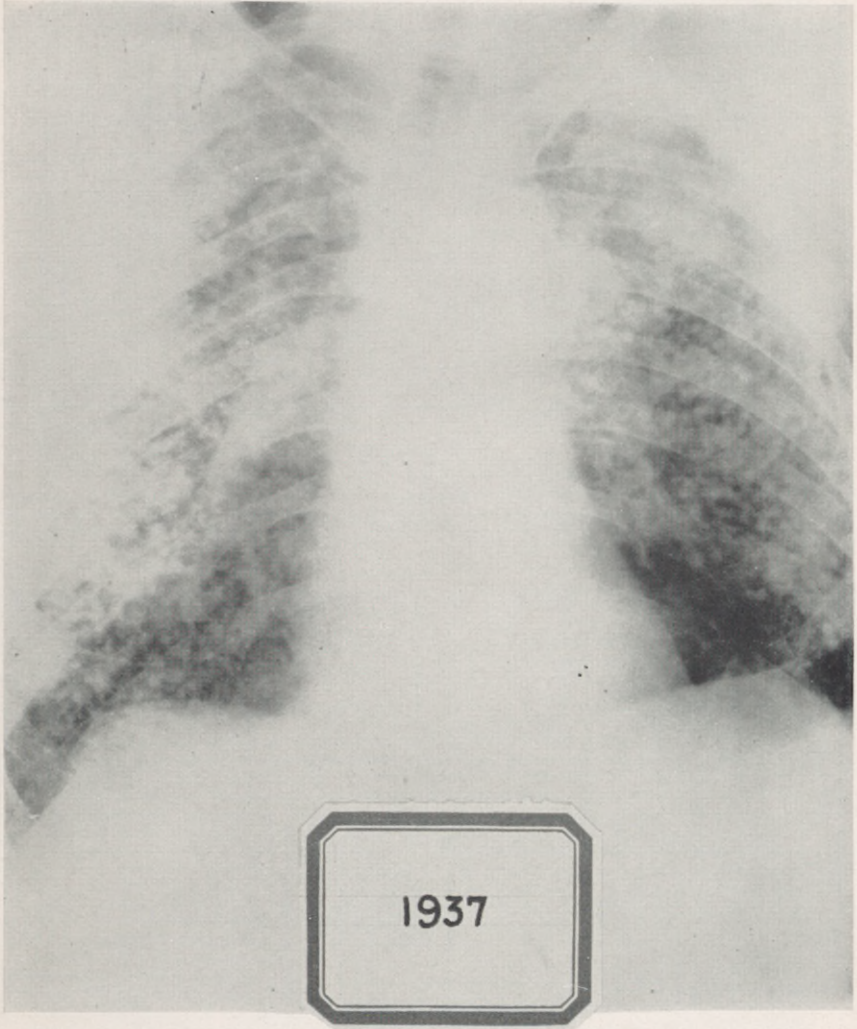
Case 87 (A-B group), plates 15 and 16, is remarkable because of the nodulation which was evident in the original X-ray. Very few of the cases had similar markings and none was as extensive as this

PLATE NO. 15.



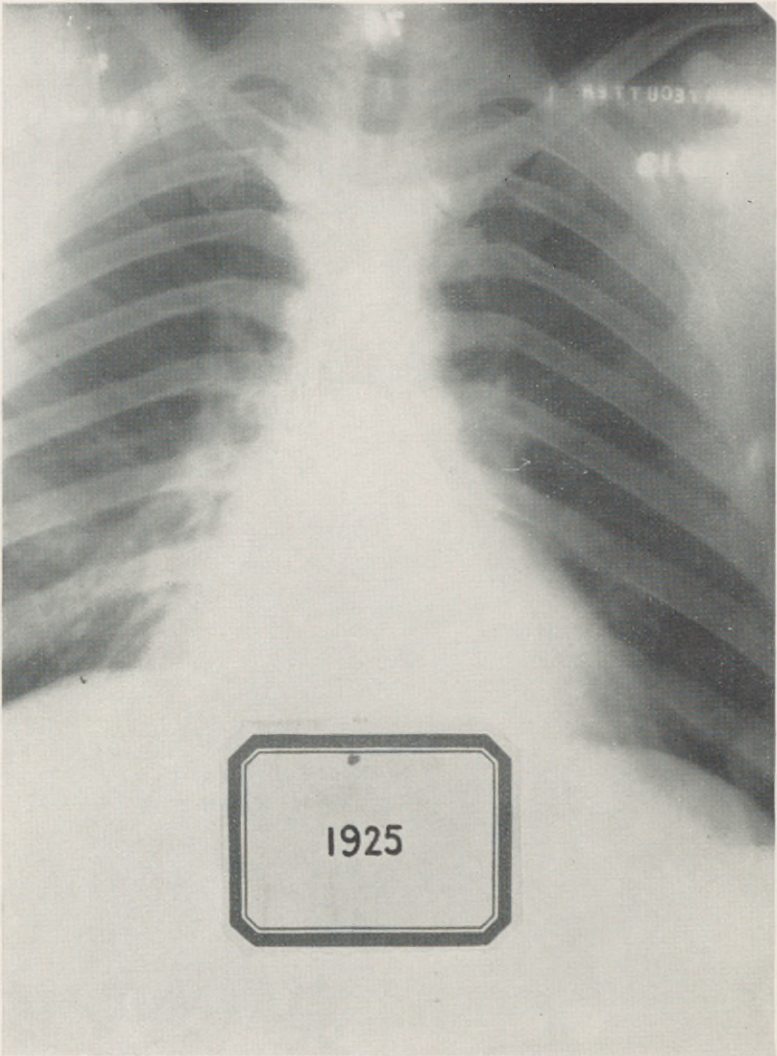
CASE 87. P. B. EXAMINED DECEMBER 11, 1925. SCOTCHMAN. AGE 52. HEIGHT 71 INCHES. WEIGHT 177 POUNDS. GRANITE CUTTER, SURFACE MACHINE OPERATOR 32 YEARS. ADVANCED SILICOSIS AND SUSPECTED LATENT TUBERCULOSIS. X-RAY NO. 188. GENERAL PHYSICAL CONDITION IS GOOD.

one. Examination in 1937 and 1938 did not show any evidence of tuberculosis, however, it seemed to be indicated in the X-ray. Compensatory emphysema is indicated in the 1925 X-ray as well as in the 1937 X-ray and the latter shows evidence of a diaphragmatic adhesion.

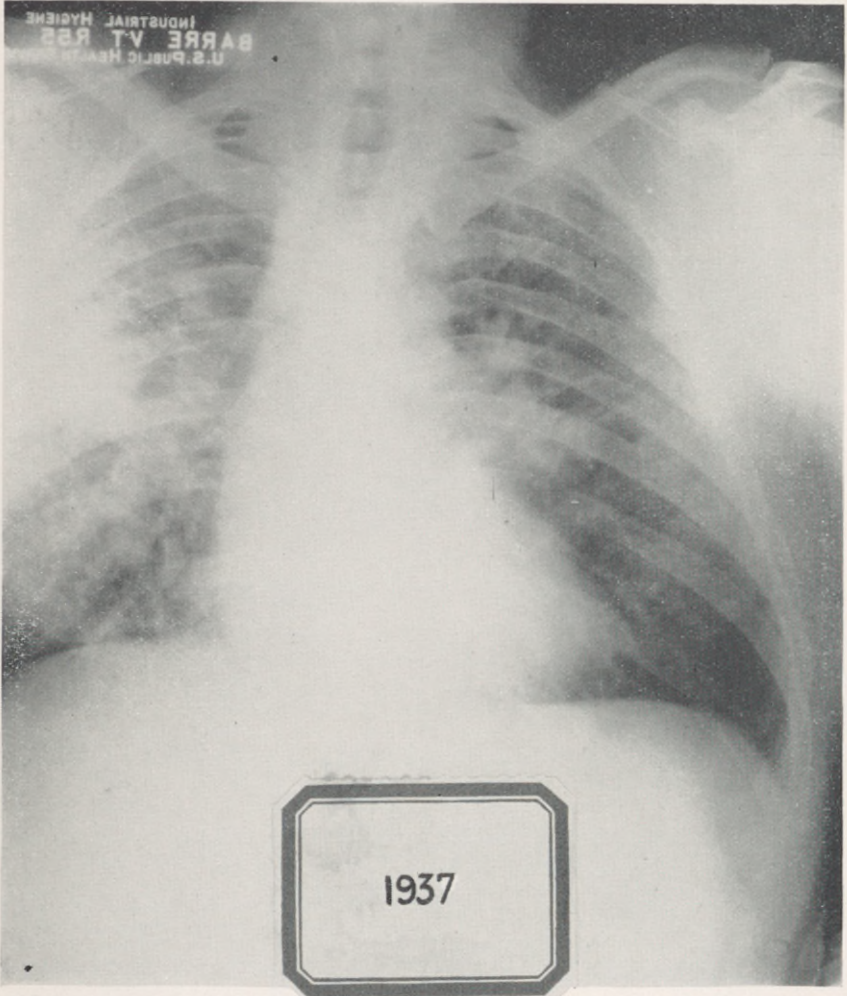


CASE 87. P. B. EXAMINED APRIL 26, 1937. AGE 64. HE HAS CONTINUED TO CUT STONE EXCEPT FOR BRIEF PERIODS SINCE PREVIOUS EXAMINATION. WEIGHT 180 POUNDS. COMPLAINS OF DYSPNEA. ADVANCED SILICOSIS WITH LATENT INFECTION.

PLATE No. 17.

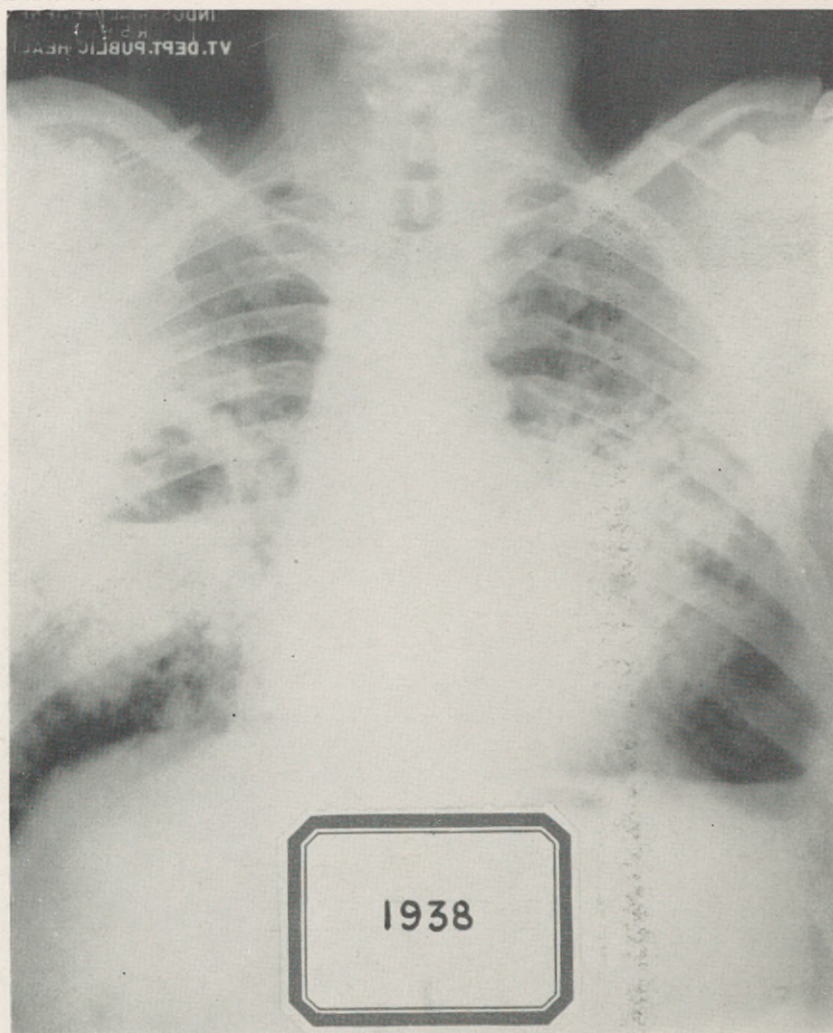


CASE 55. J. P. EXAMINED FEBRUARY 28, 1925. ITALIAN. AGE 31, HEIGHT 68 INCHES. WEIGHT 183. GRANITE CUTTER 13 YEARS. CHEST NEGATIVE. X-RAY NO. 75.



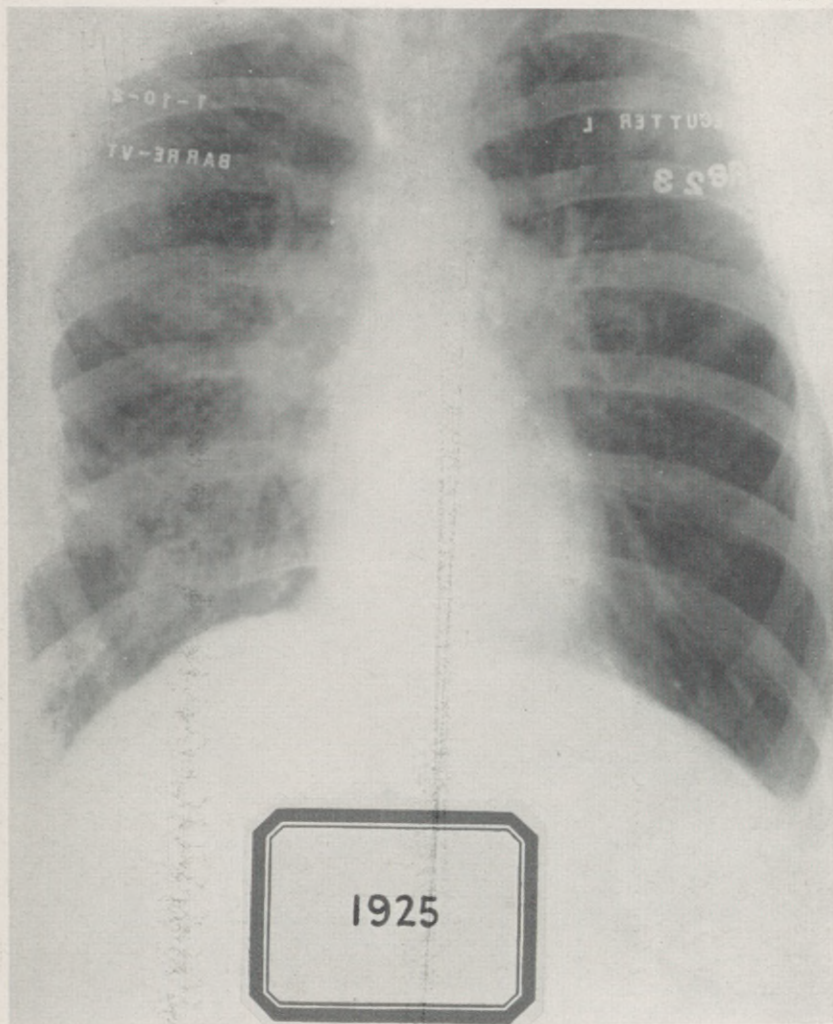
CASE 55. J. P. EXAMINED MAY 5, 1937. AGE 43, WEIGHT 190 POUNDS
HE HAS CONTINUED TO CUT STONE SINCE PREVIOUS EXAMINATION.
COMPLAINS OF SHORTNESS OF BREATH AND PAINS IN THE CHEST. SILI-
COSIS AND BEGINNING TUBERCULOSIS.

PLATE NO. 19.



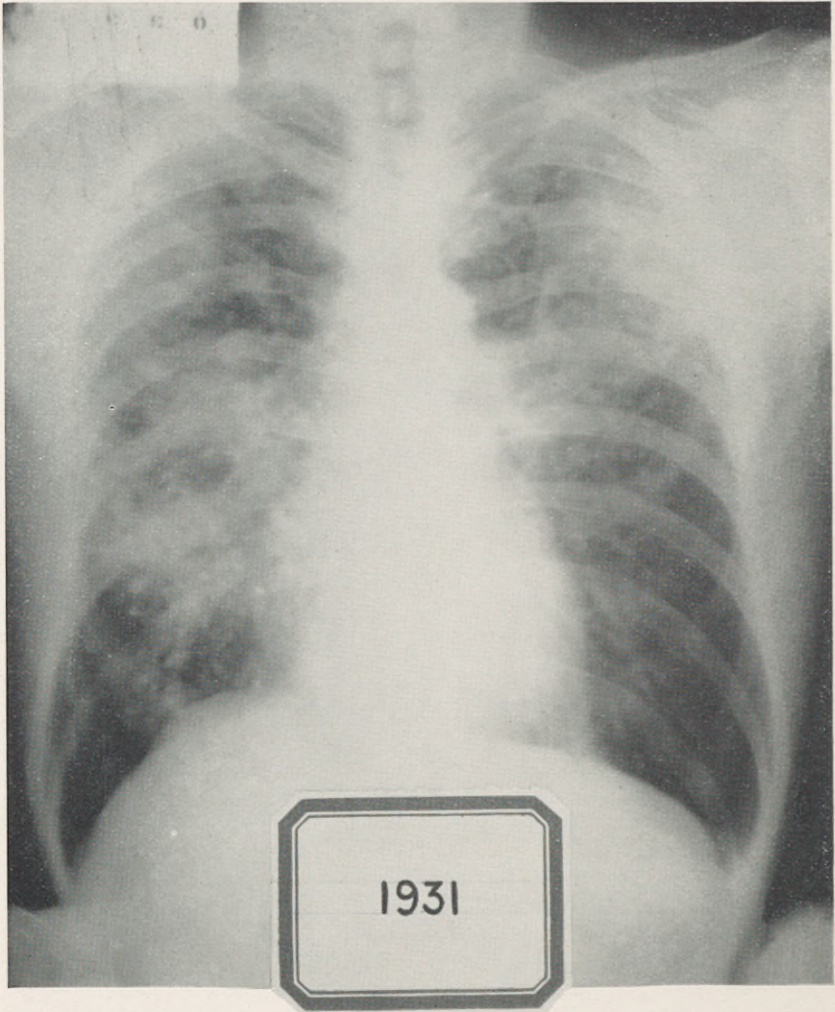
CASE 55. J. P. X-RAY MADE MARCH 1938, INDICATES THE PROGRESS OF THE TUBERCULOSIS PROCESS IN EACH LUNG. THERE IS EXTENSIVE DISEASE IN THE RIGHT LUNG WITH CAVITY FORMATION. THE FLUID LEVEL CAN BE SEEN IN THE LARGE CAVITY IN THE MIDDLE PORTION OF THE RIGHT LUNG. SPUTUM CONTAINED TUBERCLE BACILLI.

NOTE.—PATIENT DIED IN MAY 1938.

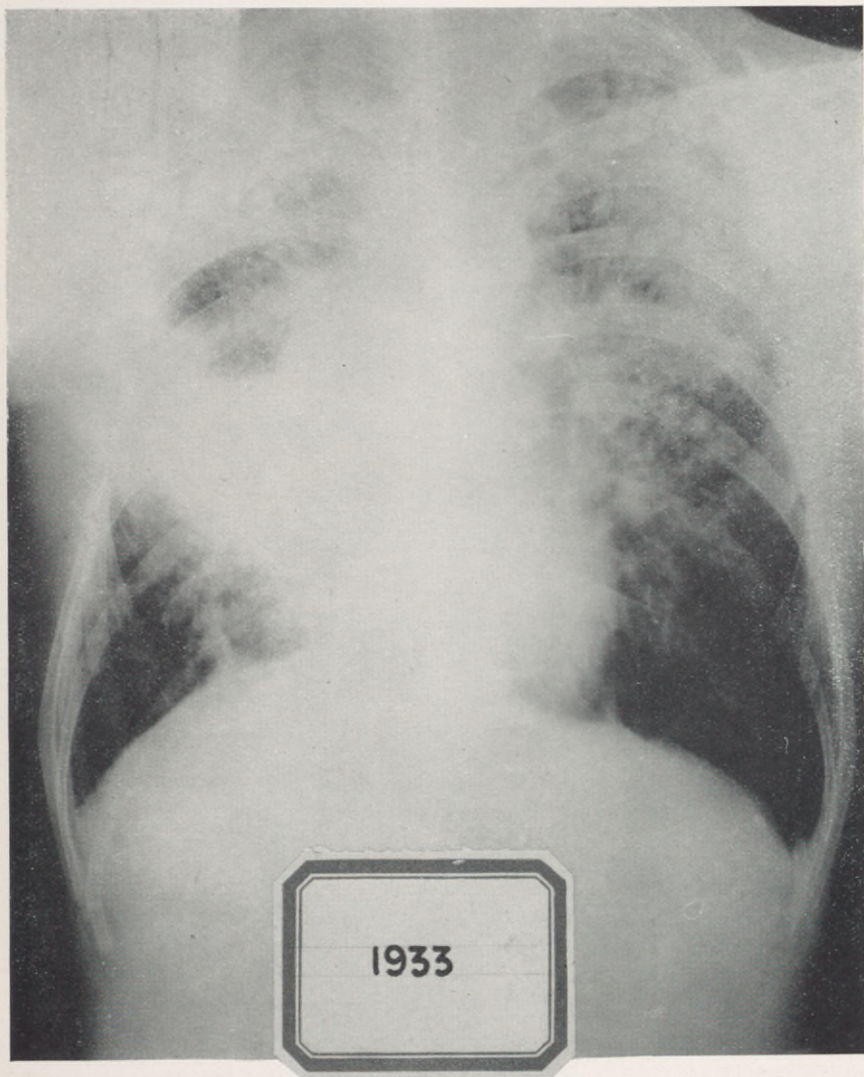


CASE —. D. S. EXAMINED 1925. SCOTCHMAN. AGE 39. HAS CUT GRANITE WITH HAND-PNEUMATIC TOOL FOR 20 YEARS. FOR THE PAST 2 YEARS HAS BEEN A SANDBLASTER. AT PRESENT HE HAS NO COMPLAINTS.

PLATE NO. 21.



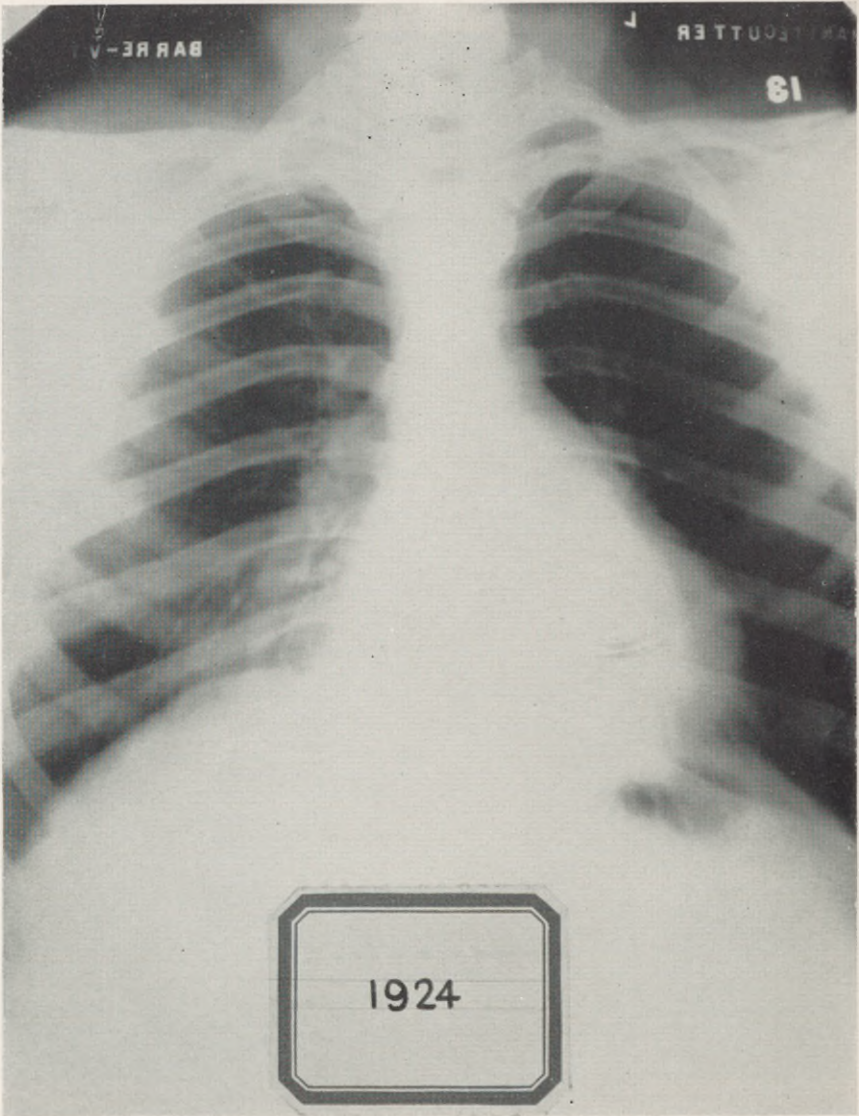
CASE —. D. S. EXAMINED AUGUST 1931. PATIENT HAS LOST WEIGHT AND APPEARS TO BE BREAKING DOWN WITH TUBERCULOSIS; HOWEVER, HE HAS NO EVIDENCE OF TOXEMIA. HIS HABITS ARE EXEMPLARY AND HE IS AN ARDENT GOLFER. COMPLAINS OF DYSPNEA ON EXERTION. X-RAY SEEMS TO INDICATE THAT THERE IS A PULMONARY INFECTION.



CASE —. D. S. EXAMINED 1933. THIS X-RAY WAS PROVIDED BY THE BARRE CITY HOSPITAL. IT WAS MADE WHEN THE PATIENT WAS ILL WITH TUBERCULOSIS. HE DIED IN 1933.

An Italian (A-B group), see plates 23 and 24, was 30 years of age at the time the 1924 X-ray was made. The examination was negative

PLATE NO. 23.

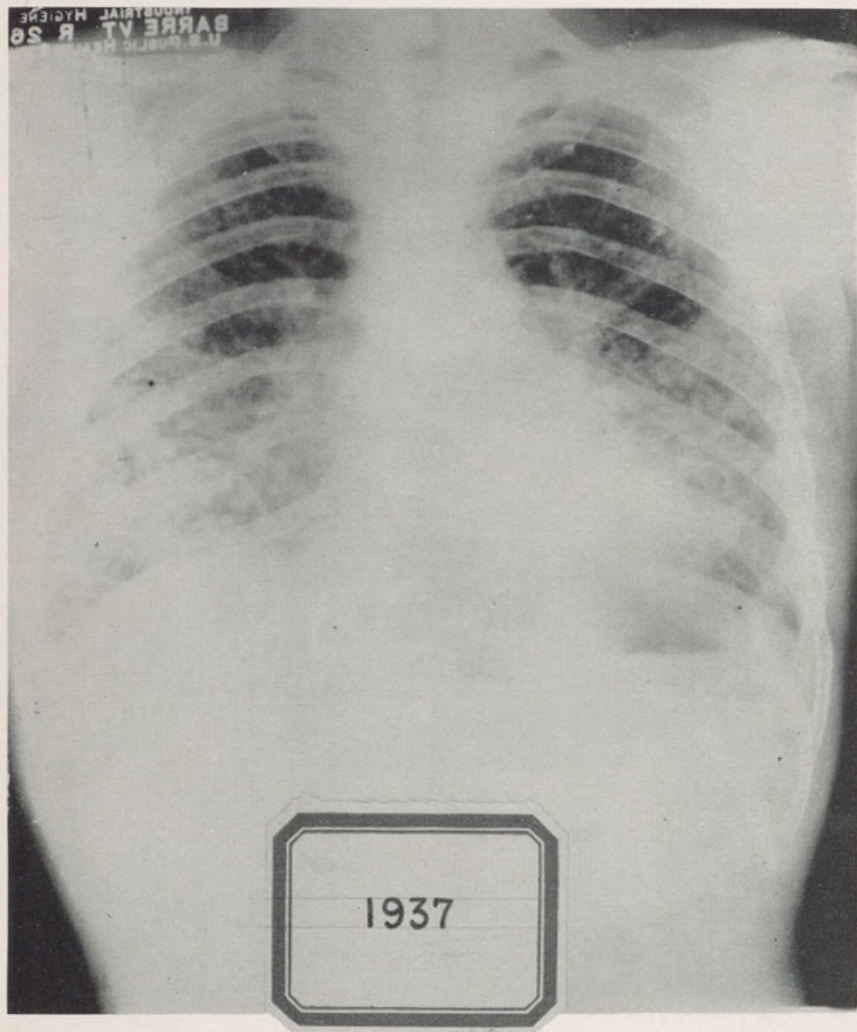


CASE 266. E. M. EXAMINED JULY 22, 1924. ITALIAN. AGE 30. GRANITE CUTTER 11 YEARS. SANDBLASTER 3 YEARS. USES POSITIVE PRESSURE HOOD. HEIGHT 62 INCHES, WEIGHT 157 POUNDS. CHEST EXAMINATION NEGATIVE. X-RAY NO. 15.

and the X-ray did not show any signs of silicosis. He had not worked for a year previous to the examination in 1937 because of rheumatic fever. At the time of examination he complained of loss of 36 pounds

in weight, fever, cough and expectoration, night sweats, and pains in the joints. There were rales in the lower portions of both lungs and the sputum contained tubercle bacilli. He died in 1938.

PLATE NO. 24.

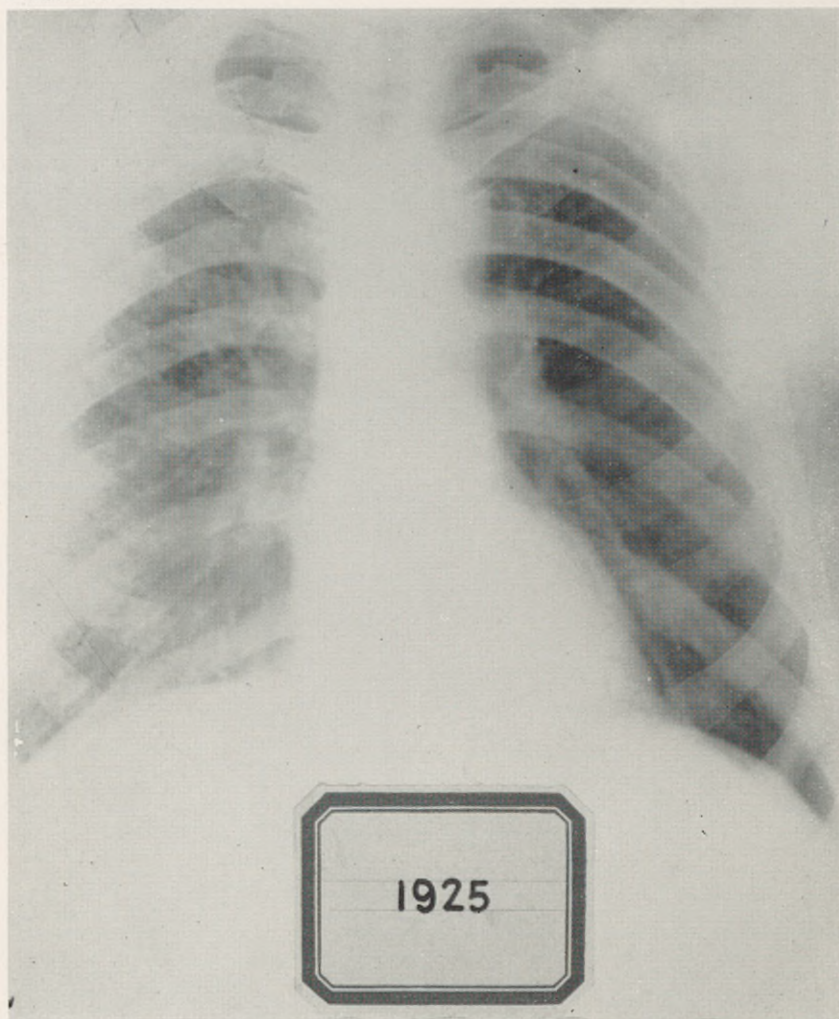


CASE 266. E. M. EXAMINED AUGUST 3, 1937. AGE 43, WEIGHT 121 POUNDS. HE CONTINUED TO WORK AS A SANDBLASTER UNTIL 5 YEARS AGO. WHEN HE BECAME FOREMAN. HE HAS NOT WORKED DURING THE PAST YEAR BECAUSE OF ILLNESS. COMPLAINS OF DYSPNEA, LOW BLOOD PRESSURE, COUGH AND EXPECTORATION, AFTERNOON TEMPERATURE AND NIGHT SWEATS AND PAINS IN THE JOINTS. ARTHRITIS, SILICOSIS, AND TUBERCULOSIS. SPUTUM CONTAINED TUBERCLE BACILLI.

NOTE.—PATIENT DIED MARCH 1938.

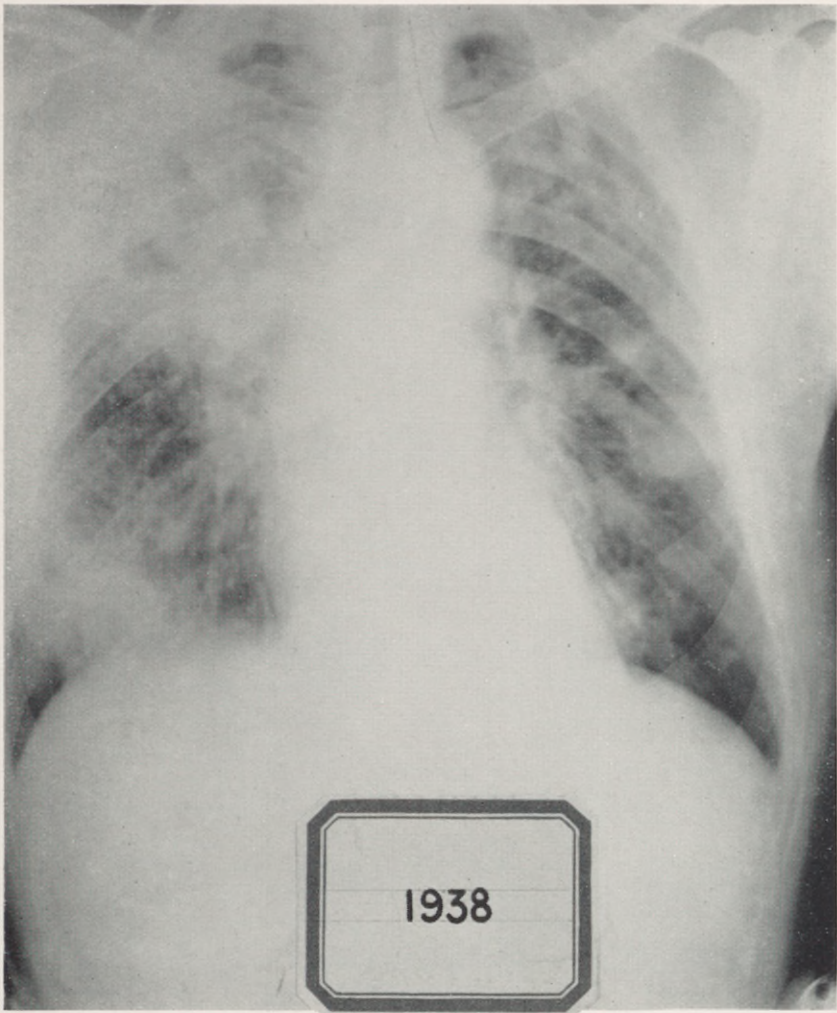
Plates 25 and 26 illustrate case No. 1, a Scotchman (A-B group), who was 56 years of age at the time of the 1925 examination. He had cut stone for 14 years in Scotland where he said that the hand-

PLATE NO. 25.



CASE 1. H. B. EXAMINED FEBRUARY 24, 1925. SCOTCHMAN. AGE 56. HEIGHT 69 INCHES, WEIGHT 176 POUNDS. GRANITE CUTTER 39 YEARS, 14 YEARS IN SCOTLAND, POSSIBLY WITH LOW DUST EXPOSURE. X-RAY NO. 78. EARLY SILICOSIS.

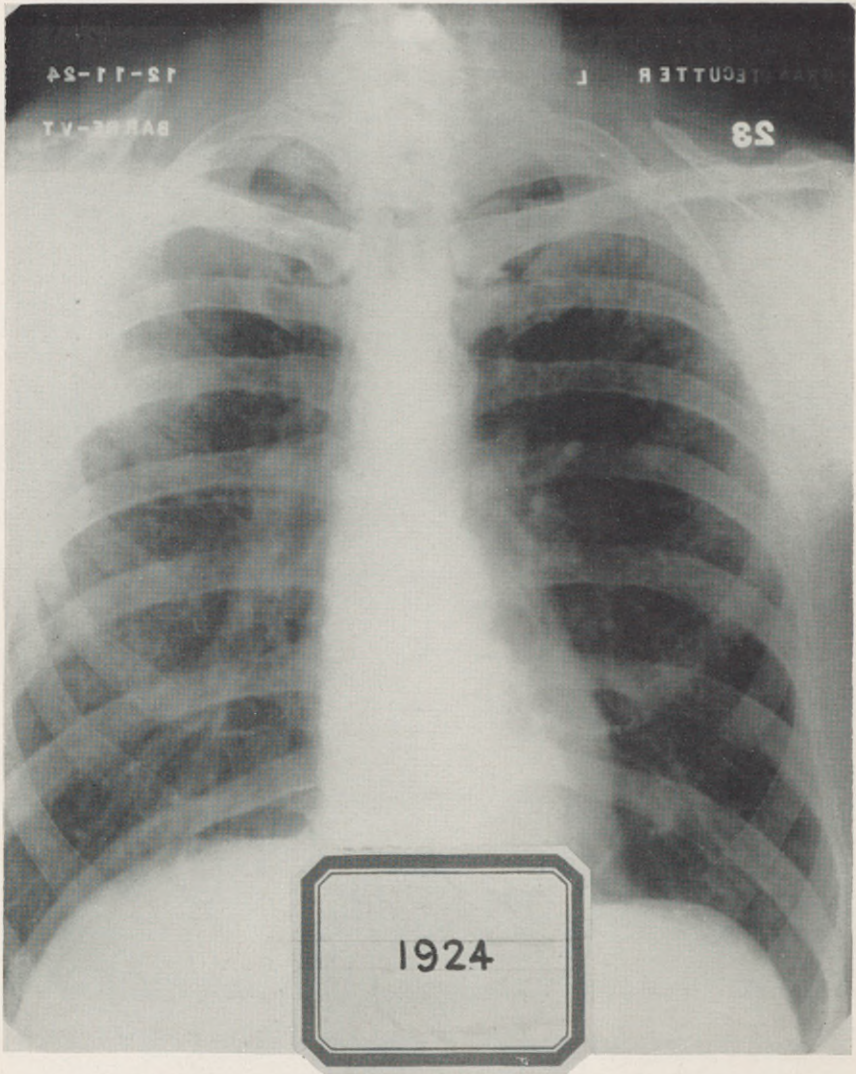
cutting had not produced as much dust as the pneumatic tools. The X-ray showed signs of very early silicosis. In 1937 he was found to have a tuberculous infection with the evidence of toxemia.



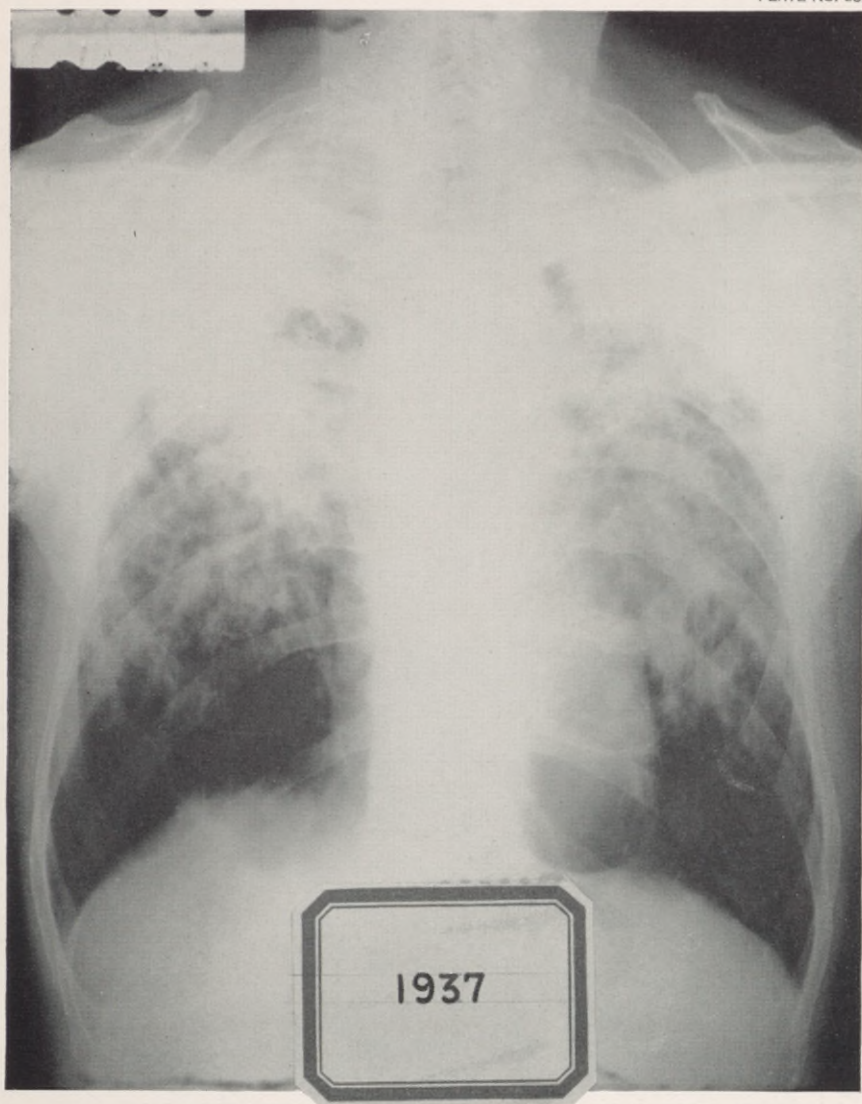
CASE 1. H. B. AGE 68. CUT GRANITE FOR MORE THAN 50 YEARS. COMPLAINED OF COUGH AND EXPECTORATION, HEMOPTYSIS, PAINS IN THE CHEST, FEVER, LOSS OF WEIGHT, AND SEVERE DYSPNEA. ADVANCED SILICOSIS AND TUBERCULOSIS. CAVITATION IN THE RIGHT UPPER LOBE. SPUTUM CONTAINED TUBERCLE BACILLI.

NOTE.—PATIENT DIED AUGUST 19, 1938.

PLATE NO. 27.



CASE 57. H. C. EXAMINED DECEMBER 11, 1924. CANADIAN. AGE 40. HEIGHT 70 INCHES, WEIGHT 160 POUNDS. GRANITE CUTTER 21 YEARS. EARLY SILICOSIS. X-RAY NO. 36.



CASE 57. H. C. EXAMINED MAY 6, 1937. AGE 53. HE CONTINUED TO CUT GRANITE EXCEPT FOR SHORT INTERVALS DURING THE DEPRESSION. QUIT WORK IN NOVEMBER 1936, BECAUSE OF ILLNESS. COMPLAINED OF DYSPNEA, WHICH WAS EXTREME ON SLIGHT EXERTION, COUGH AND EXPECTORATION, WHICH WAS BLOODY AT TIMES, AFTERNOON TEMPERATURE, LOSS OF WEIGHT, AND WEAKNESS. CHEST SHOWS EVIDENCE OF ADVANCED TUBERCULOSIS AND SILICOSIS. SPUTUM CONTAINED TUBERCLE BACILLI.

NOTE.—PATIENT DIED FEBRUARY 1938.

In Table 1 is given a tabulation of the cases studied in 1937 who continued at their same occupations. The estimate of progress has been indicated in the last three columns:

Table 1.—Cases of granite cutters (group A-B) who continued at occupation

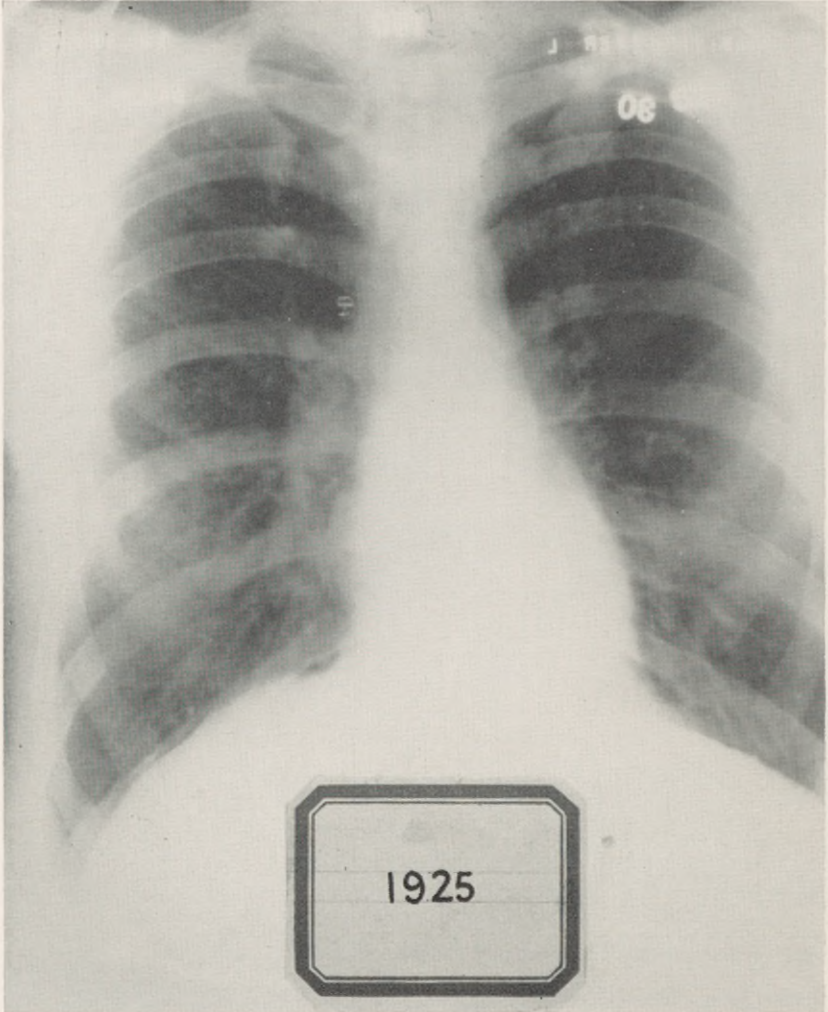
Initials	Case No.	1937 age	Years in occupation by 1937	Diagnosis (1925)	Diagnosis (1937)	Progress	Remarks
E. M.	248	34	14	Negative for silicosis	Negative for silicosis	None	Latent.
G. C.	300	39	15	do	do	Moderate	Out 5 years for military service.
J. P.	55	37	11	do	do	Slight	
E. C.	258	47	21	do	do	do	
I. M.	283	47	28	do	do	do	
G. S.	232	37	16	do	do	Moderate	
J. P.	60	40	23	do	do	do	
E. B.	43	26	16	More fibrosis than normal	do	do	
J. C.	259	37	16	Negative for silicosis	do	do	
C. C.	253	43	15	do	do	do	
C. G.	276	45	25	do	Moderate silicosis	do	
J. D.	331	50	30	do	do	do	
J. L.	148	63	48	do	do	do	
S. L.	30	43	26	Moderate silicosis	do	do	Irregular employment for last 5 years.
L. O.	249	37	21	Negative for silicosis	do	do	
C. B.	224	44	19	do	do	do	
I. L.	202	31	15	do	do	do	
A. C.	94	41	23	do	do	do	
A. A.	78	50	33	do	do	do	
P. P.	286	54	21	Moderate silicosis	do	do	
J. B.	238	52	27	do	do	do	
A. D.	330	47	26	Early silicosis	do	do	
J. L.	6	46	28	Negative for silicosis	do	do	Tabes.
C. W.	4	50	26	do	do	do	
A. R.	201	52	31	do	do	do	Syphilis and suspected tuberculosis.
E. S.	244	53	28	do	do	do	
W. T.	263	53	28	do	do	do	
A. C.	255	50	33	do	do	do	
G. R.	313	55	33	do	do	do	
P. B.	95	37	20	Negative for silicosis	do	do	
F. R.	220	57	37	do	do	do	
O. A.	27	53	21	do	do	do	
M. B.	261	47	32	Negative for silicosis	do	do	
N. B.	278	55	33	do	do	do	
R. S.	227	60	33	do	do	do	
J. M.	32	52	35	Moderate silicosis	do	do	
L. C.	298	51	27	do	do	do	
J. M.	219	59	34	do	do	do	
P. B.	87	64	44	do	do	do	Do.

R. C.	99	Moderate silicosis	Advanced silicosis—tuberculosis 1940	Marked	Suspected tuberculosis, Died
T. B.	336	do	Advanced silicosis	do	1940
J. S.	186	do	do	Moderate	Suspected tuberculosis, Died
G. P.	3	do	do	Marked	1940
D. C.	107	Early silicosis	Advanced silicosis—tuberculosis	do	Died 1939.
E. G.	44	do	do	do	Died 1937.
F. M.	250	Negative for silicosis	Moderate silicosis	Moderate	Suspected tuberculosis.
A. R.	230	do	Advanced silicosis	Marked	Do.
A. C.	104	Moderate silicosis	Advanced silicosis—tuberculosis	do	Died 1937.
H. B.	135	do	do	do	Died 1933.
D. S.	500	do	do	do	Died 1938.
J. J.	11	Early silicosis	do	do	Died 1933.
C. G.	501	Advanced silicosis	Advanced silicosis (1931—tuberculosis)	do	Died 1933.
J. P.	55	Negative for silicosis	Advanced silicosis—tuberculosis	do	Died 1938.
H. C.	57	Early silicosis	do	do	Died 1937.
G. S.	176	Moderate silicosis	do	do	Died 1939.
E. M.	266	Negative for silicosis	do	do	Died 1937.
D. C.	91	Early silicosis	do	do	Died 1939.
P. G.	306	Early silicosis, Susp. tuberculosis	do	do	Died 1938.
H. B.	1	Moderate silicosis	do	do	Died 1937.
L. B.	63	do	do	do	Do.
A. M.	9	do	do	do	Do.
A. S.	264	do	do	do	Do.
P. D.	225	do	do	do	Died 1938.
A. C.	138	do	do	do	do.
W. M.	24	do	do	do	Died 1937.

GRANITE CUTTERS, GROUPS A-B, WHO CHANGED TO NON DUSTY OCCUPATIONS

One of the unusual features of silicosis in granite workers is its progress after the cessation of exposure to dust. If the condition was

PLATE NO. 29.

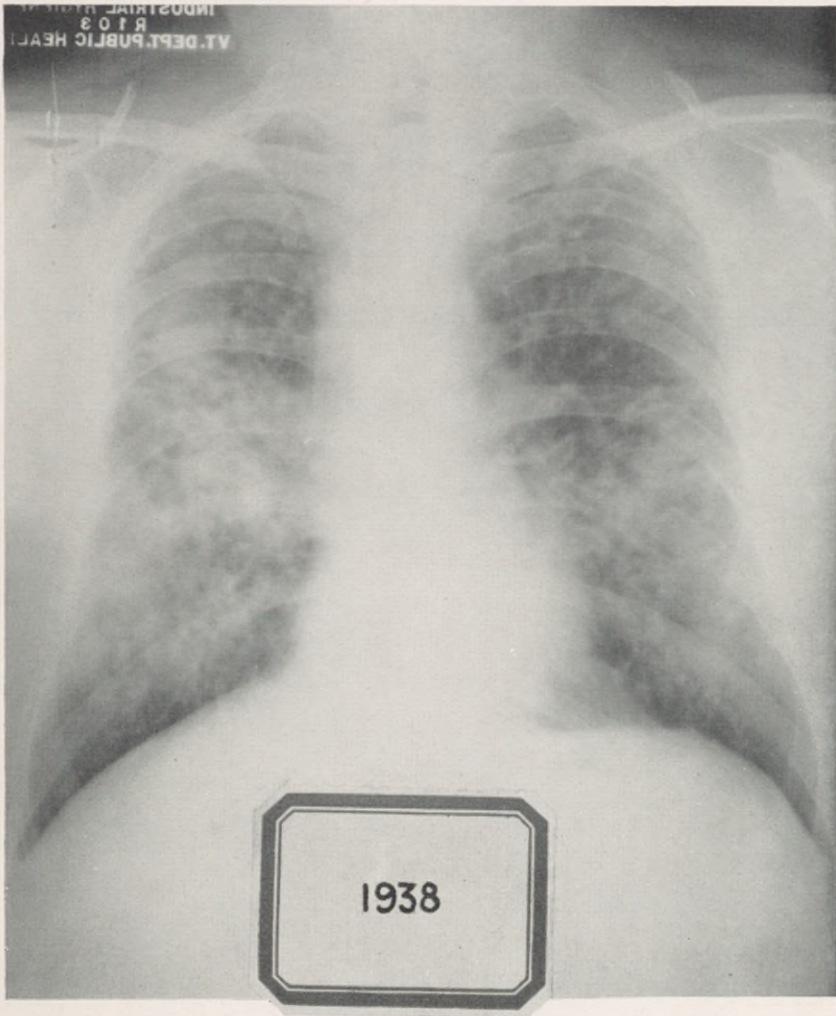


CASE 103. R. A. EXAMINED DECEMBER 11, 1925. ITALIAN. AGE 42. GRANITE CUTTER 30 YEARS. HEIGHT 66 INCHES, WEIGHT 159 POUNDS. EARLY SILICOSIS.

well established, its course and prognosis seemed to be altered very little by the removal of the worker to a nondusty occupation. It is questionable if the early cases without any infection exhibit this characteristic; however, more information is needed on this phase of the subject. A change in occupation did not seem to materially

lessen the chances of escaping a final tuberculous complication in the more advanced cases of silicosis. This was exemplified in the granite manufacturers, most of whom had been stone cutters before starting in business for themselves, and evidently had silicosis. It was found

PLATE NO. 30.

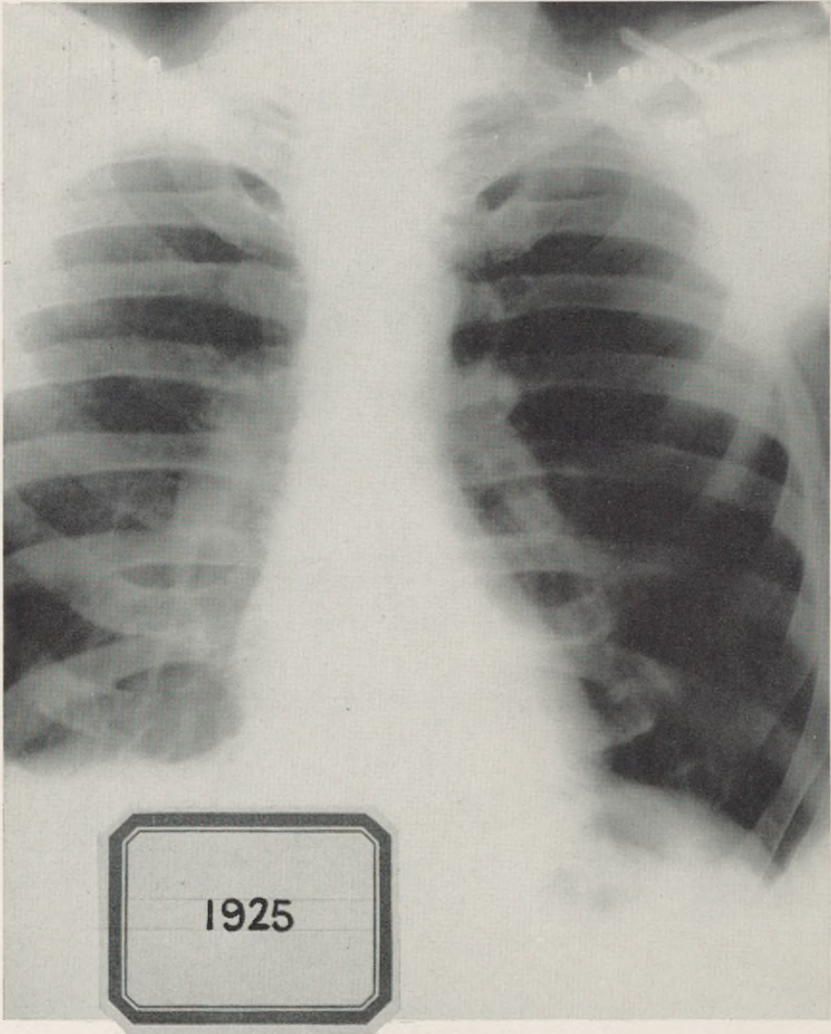


CASE 13. R. A. EXAMINED MAY 29, 1938. HAS NOT CUT GRANITE FOR 7 YEARS. HAS BEEN A GRANITE SALESMAN. COMPLAINS OF BRONCHITIS AND DYSPNEA. WEIGHT 179 POUNDS. ADVANCED SILICOSIS.

that the death rate of granite manufacturers from tuberculosis was almost the same as for granite cutters. In most instances, their social and economic conditions were even better than that of the granite cutters, which incidentally was above the average for industrial workers outside the granite industry.

The progress of silicosis after cessation of exposure has been referred to by other investigators. In South Africa, it was found that "a steady fall over a period of years in dust concentration is not associated

PLATE NO. 31.



CASE 170. J. S. EXAMINED JULY 3, 1925. SCOTCHMAN. AGE 51. HEIGHT 68 INCHES. GRANITE CUTTER 35 YEARS, 24 YEARS WITH PNEUMATIC TOOL. SLIGHT INCREASE IN FIBROSIS.

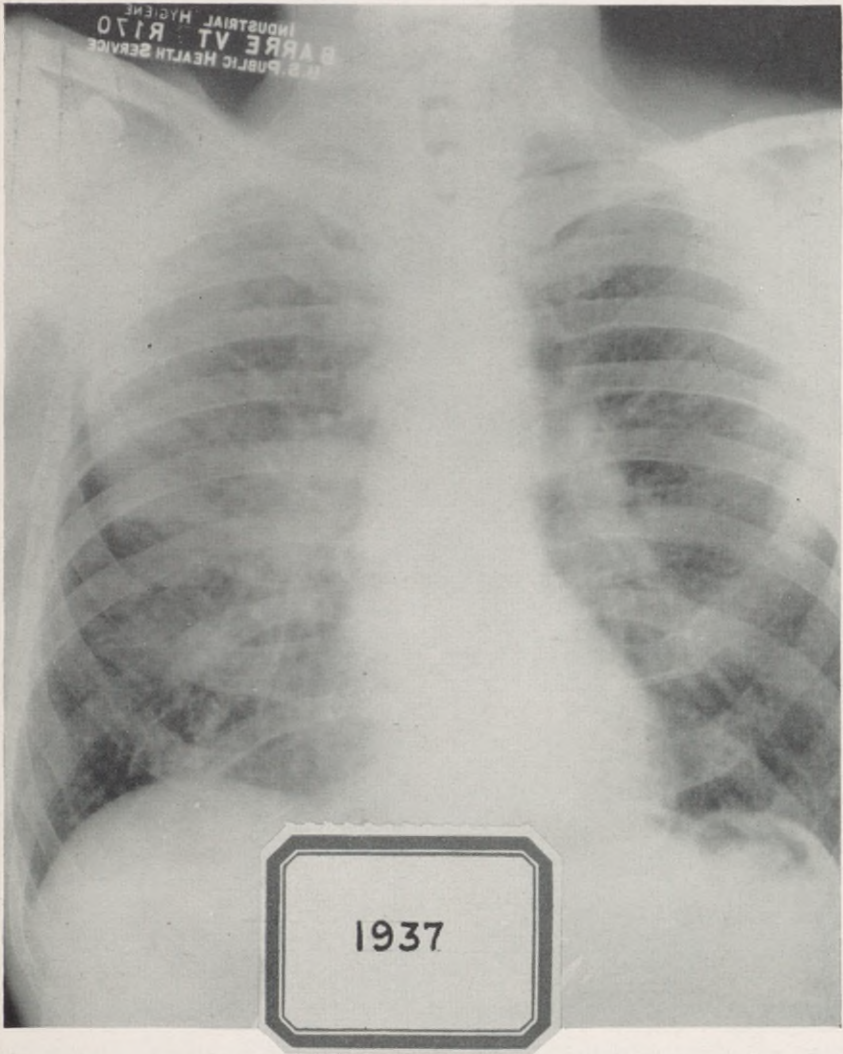
with the corresponding fall in the silicosis incidence."⁵ Britten⁶ reports two cases of workers who had worked in dusty occupations

⁵ South African Institute of Medical Research, Annual Report, Year ending 1925.

⁶ Britten, James A.: Silicosis a Modern Factory Hazard. *Industrial Hygiene*, September 1924.

for 7 and 8 years and later changed to nondusty occupations where they worked 8 and 9 years. They developed pulmonary symptoms and were found to be suffering from silicosis and tuberculosis.

PLATE No. 32

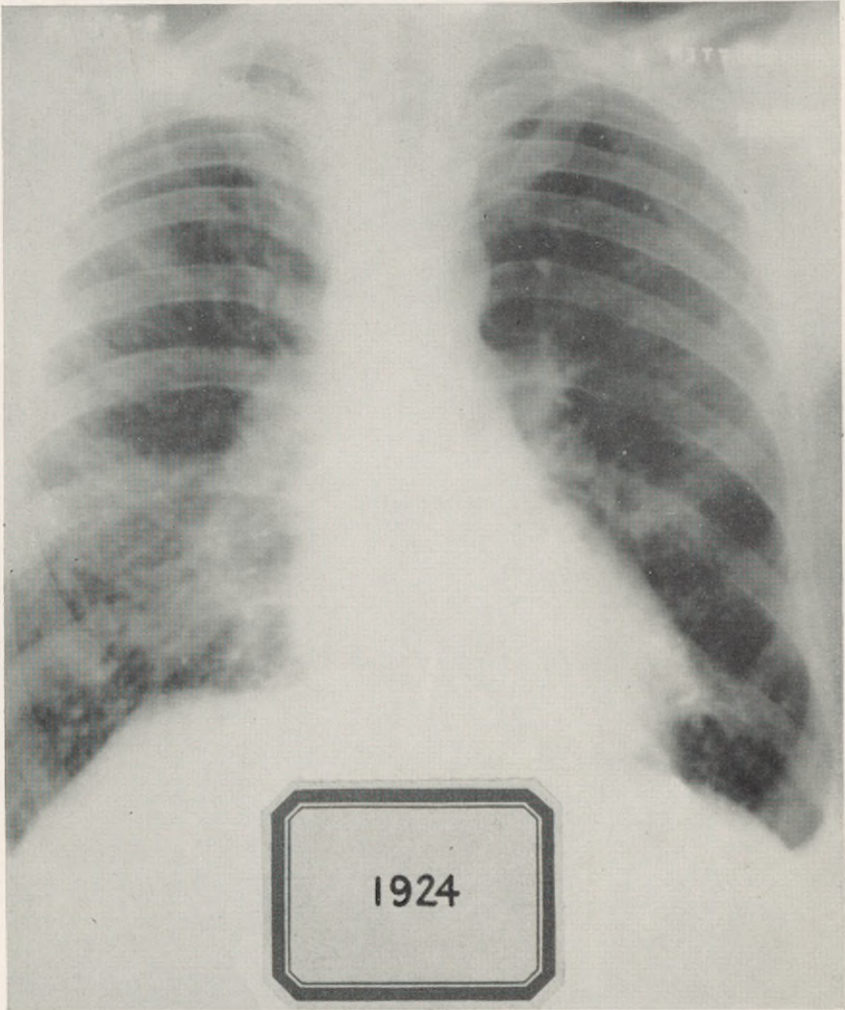


CASE 170. J. S. EXAMINED JUNE 22, 1937. AGE 63, WEIGHT 148 POUNDS. PATIENT CONTINUED TO CUT GRANITE 4 YEARS, AND SINCE THAT TIME HAS BEEN WORKING ON A FARM. MODERATE SILICOSIS AND SUSPECTED TUBERCULOSIS.

Case 93, an Italian, changed from the occupation of carver to draftsman in 1926 and worked at his new trade in his home. He had been an expert carver and statuary cutter. His mode of living and habits were exemplary. The 1924-25 X-rays indicated that he had a moder-

ate amount of silicosis. The 1937 X-ray indicates that there was an advanced tuberculosis present, involving both lungs. He complained of weakness, cough and expectoration, dyspnea, loss of weight, temper-

PLATE NO. 33.



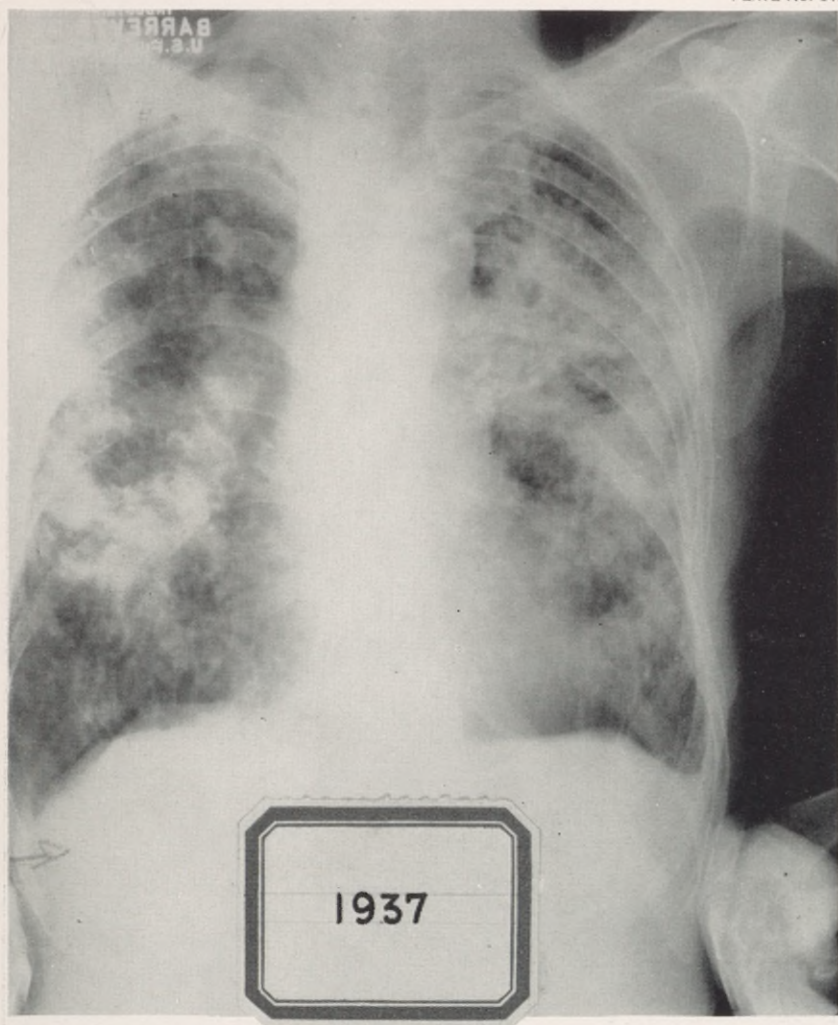
CASE 93. J. B. EXAMINED MAY 26, 1924. ITALIAN. AGE 41, HEIGHT 66 INCHES, WEIGHT 147 POUNDS. STATUARY AND DESIGN CUTTER 21 YEARS. MODERATE SILICOSIS. X-RAY NO. 68.

ature, and night sweats. Sputum contained tubercle bacilli. Patient died in September, 1937.

The change in the type of heart shadow as shown in the X-rays of this patient is consistent with experience in tuberculosis among per-

sons not in dusty trades. Apparently it results from toxemia of tuberculosis.

PLATE NO. 34.



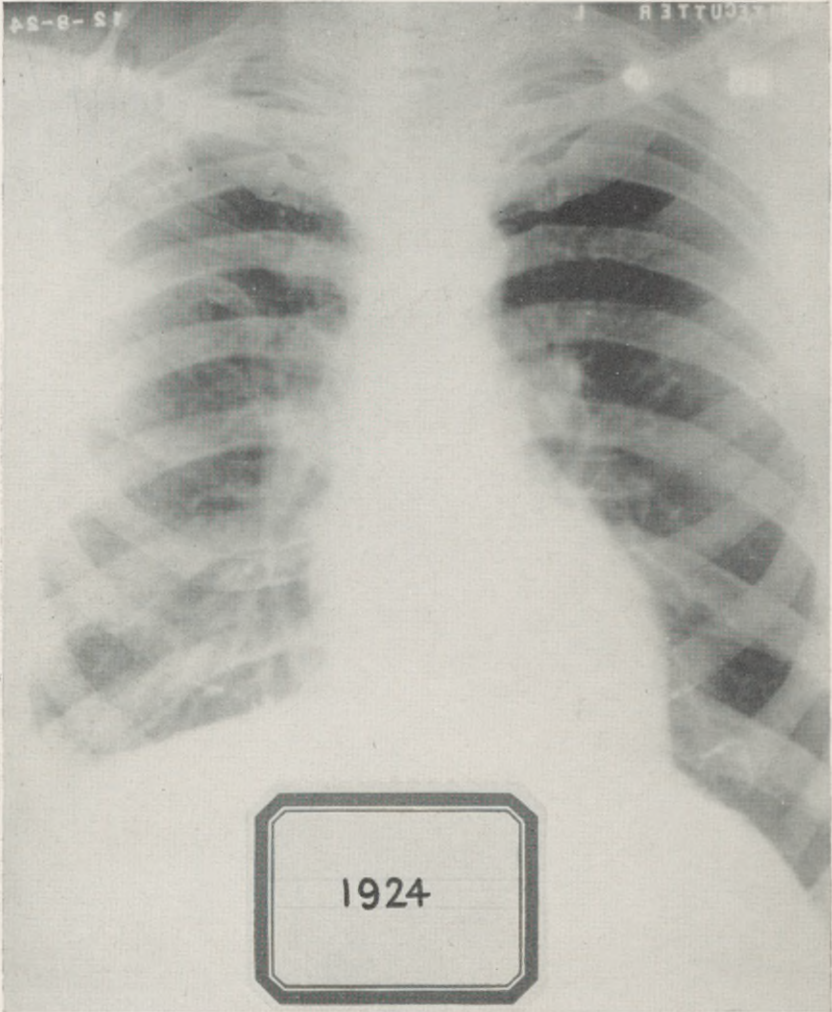
CASE 93. J. B. EXAMINED MAY 26, 1937. AGE 54, WEIGHT 130 POUNDS. SINCE 1926 HE HAS BEEN WORKING AS A DRAFTSMAN IN HIS OWN HOME. COMPLAINS OF WEAKNESS, COUGH AND EXPECTORATION, DYSPNEA AND LOSS OF WEIGHT. CHEST SHOWS EVIDENCE OF SILICOSIS AND ADVANCED TUBERCULOSIS.

NOTE.—PATIENT DIED SEPTEMBER 1937.

Case 40, an Italian, was 48 years of age when he was examined in 1924 and had cut granite for 25 years. X-ray showed evidence of early silicosis. He stopped work in 1930 and did not engage in any

dusty occupation. Two years prior to the 1937 examination he began to lose weight and this continued until he was emaciated. He complained of weakness, marked dyspnea, cough and expectoration, and

PLATE NO. 35.



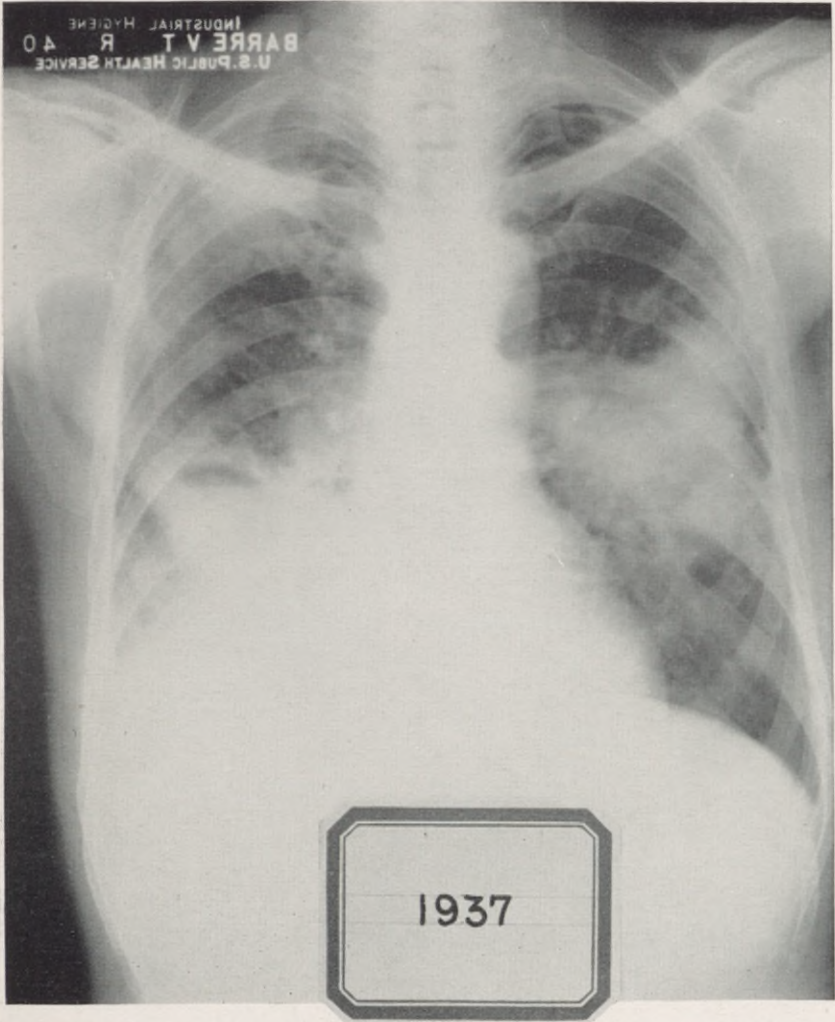
CASE 40. J. B. EXAMINED DECEMBER 5, 1924. ITALIAN. AGE 48, HEIGHT 66 INCHES, WEIGHT 162 POUNDS. GRANITE CUTTER 25 YEARS. MODERATE SILICOSIS.

pains in the chest. Sputum contained tubercle bacilli. Patient died in August 1938.

In the 1937 X-ray there are unmistakable signs of advanced tuberculosis, with a cavity in the base of the right lung. The relatively clear apices are remarkable.

A visit to the patient in 1938 revealed that he was bedfast and extremely emaciated and weak. His daughter has developed active tuberculosis during the past year.

PLATE No. 36.



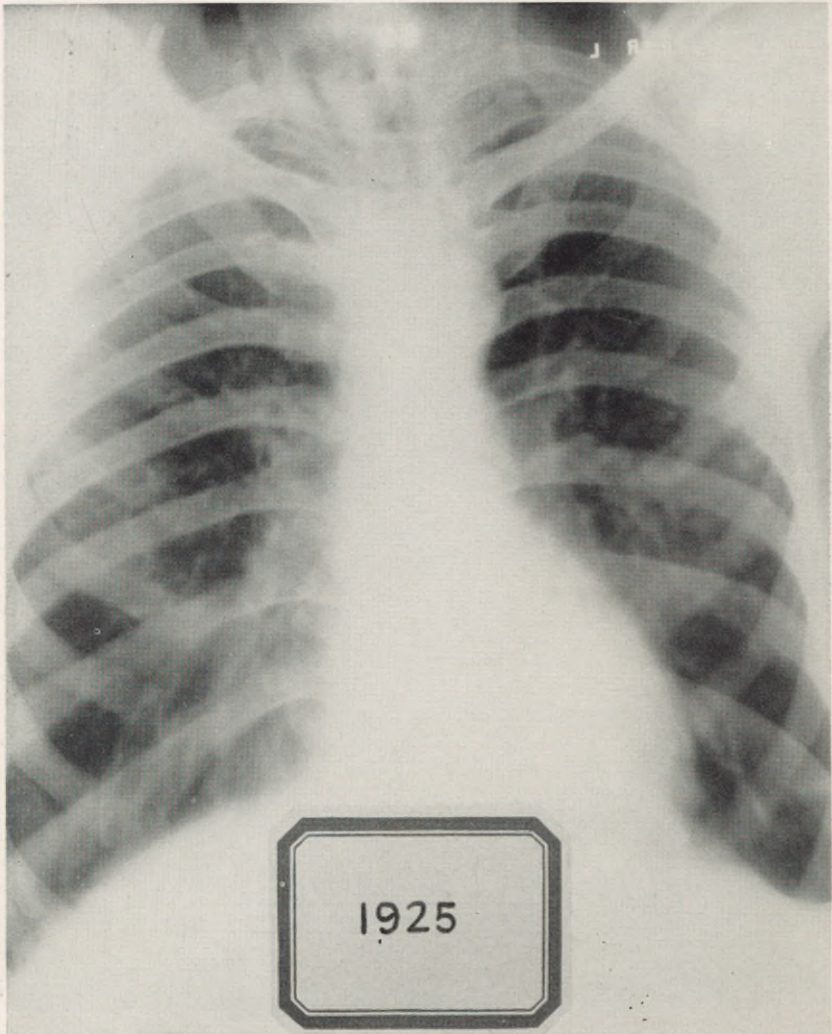
CASE 40. J. B. EXAMINED APRIL 29, 1937. AGE 62. CONTINUED TO CUT GRANITE UNTIL 1930. HAS NOT WORKED SINCE THAT TIME. PRESENT ILLNESS BEGAN 2 YEARS AGO WITH LOSS OF WEIGHT, WEAKNESS, AND A PRODUCTIVE COUGH. SPUTUM POSITIVE FOR TUBERCLE BACILLI. CHEST SHOWS ADVANCED TUBERCULOSIS, WITH CAVITATION IN THE RIGHT BASE, AND SILICOSIS. APICES RELATIVELY CLEAR.

NOTE.—PATIENT DIED AUGUST 11, 1938.

Case 105, plates 37 and 38, an Irishman who was 61 years of age at the time of the 1937 examinations. The 1925 X-ray revealed more fibrosis than normal but otherwise nothing of interest. He had been

cutting granite for 13 years at that time, which means that he did not start at the trade as early in life as the average granite cutter. He stopped working in the dust in 1932 at which time he had been exposed

PLATE NO. 37.

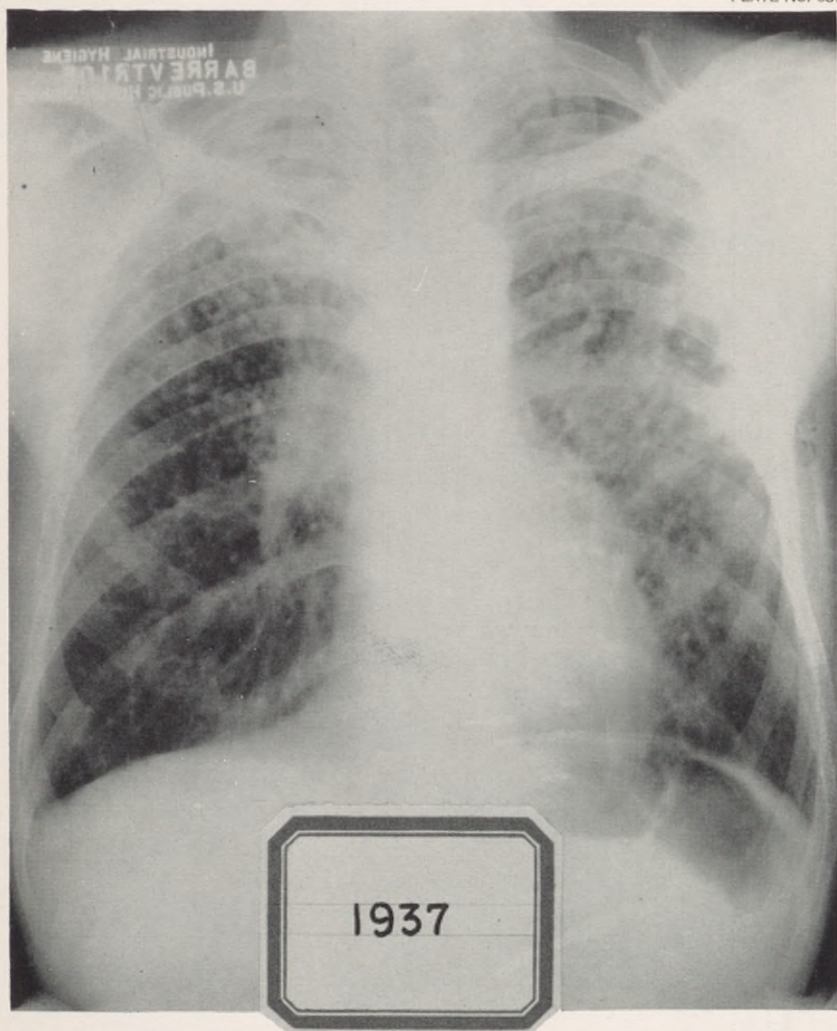


CASE 105. J. G. EXAMINED FEBRUARY 16, 1925. IRISHMAN. AGE 49. HEIGHT 68 INCHES, WEIGHT 141 POUNDS. GRANITE CUTTER (SURFACE MACHINE OPERATOR) 13 YEARS. MORE FIBROSIS THAN NORMAL. X-RAY NO. 66.

to dust for 20 years. He changed to a nondusty trade and continued working until a few months prior to the 1937 examination. There was evidence of advanced tuberculosis with cavity formation in the left upper lobe. He complained of general weakness, fever, cough,

loss of weight and strength, night sweats, and pains in the chest. The sputum contained tubercle bacilli. The patient died in 1937.

PLATE NO. 38.



CASE 105. J. G. EXAMINED MAY 29, 1937. AGE 61, WEIGHT 130 POUNDS. PATIENT CONTINUED TO CUT GRANITE UNTIL 5 YEARS AGO. SINCE THAT TIME HE HAS BEEN A LABORER IN A CEMETERY, ALTERNATING BETWEEN GENERAL WORK AND GRAVE DIGGING (NOT DRY). COMPLAINS OF GENERAL WEAKNESS, PAINS IN THE CHEST, AND A PRODUCTIVE COUGH. SPUTUM POSITIVE FOR TUBERCLE BACILLI. HAS NOT WORKED FOR LAST FEW MONTHS DUE TO ILLNESS. CHEST SHOWS EVIDENCE OF TUBERCULOSIS IN BOTH LUNGS WITH CAVERNOUS BREATHING IN THE LEFT UPPER LOBE. TUBERCULOSIS AND SILICOSIS

NOTE.—PATIENT DIED IN NOVEMBER 1937.

This case is of interest in that the patient did not start cutting granite as early as is usual with granite cutters.

Table 2.—Cases of granite cutters (groups A-B) who changed to nondusty occupations

Initials	Case No.	1937 age	Years in dust	Years out of dust	Diagnosis (1925)	Diagnosis (1937)	Progress	Remarks
L. L.	314	41	6	13	More fibrosis than normal.	Negative for silicosis—latent tuberculosis	None for silicosis.	Fibrosis undoubtedly due to old tuberculosis.
R. M.	62	53	24	13	do.	do.	Slight.	
A. M.	88	44	19	6	do.	do.	do.	
J. F.	104	48	12	8	Negative for silicosis.	do.	Moderate.	
J. M.	175	46	19	15	More fibrosis than normal.	do.	Slight.	
A. B.	97	50	21	12	Early silicosis	Moderate silicosis.	Moderate.	
A. C.	255	50	17	15	do.	do.	do.	
N. B.	240	48	30	9	do.	do.	do.	Out of dust 20 years.
F. H.	318	60	27	11	do.	do.	do.	Asthma.
C. A.	55	32	21	7	do.	do.	do.	
J. S.	173	43	39	8	do.	do.	do.	
B. P.	182	53	22	12	do.	Advanced silicosis	Marked	Suspected tuberculosis.
R. A.	103	54	35	7	do.	do.	do.	Do.
J. B.	40	62	23	11	Moderate silicosis	Advanced silicosis—tuberculosis	do	Died 1937.
J. G.	105	61	30	5	do.	do.	do	Do.
W. W.	301	55	27	12	do.	do.	do	Do.
P. A.	226	52	27	10	do.	do.	do	do

Table No. 2 has been made from histories of cases studied in 1937 of former granite cutters who changed to nondusty occupations. There was definite evidence of progress of silicosis in all patients except one. This patient had an early tuberculous lesion in the apex of the right lung and some fibrosis associated with it. He had been exposed to dust only 6 years and had been out of it for 13 years. It is not possible to state that the condition has progressed as he had no signs of silicosis in 1925 and 1937—only the tuberculous lesion.

In this group the progress seems to have been proportionate to the extent of dust exposure.

LOW DUST EXPOSURE, GROUPS C-D

The following cases are presented as controls inasmuch as they are those workers who were exposed to a dusty atmosphere of the average plant dustiness (20 million particles per cubic foot) or less (groups C and D). These groups of workers were exposed to the same type of dust as were A and B but in much less concentration and the result of exposure is quite different. The difference in the amount of sickness and death rates as well as the incidence of silicosis and tuberculosis has been stressed. The variation in exposure is one of intensity inasmuch as the dust was the same. This points out the importance of dust counts to determine the extent of dustiness. Exposure to silica dust in certain trades did not produce silicosis, and for this reason the etiology of silicosis was obscure since exposure in other trades produced the condition. The difference in effect of silica dust was found to be a matter of extent of concentration, when methods of dust counting were evolved and put into use.

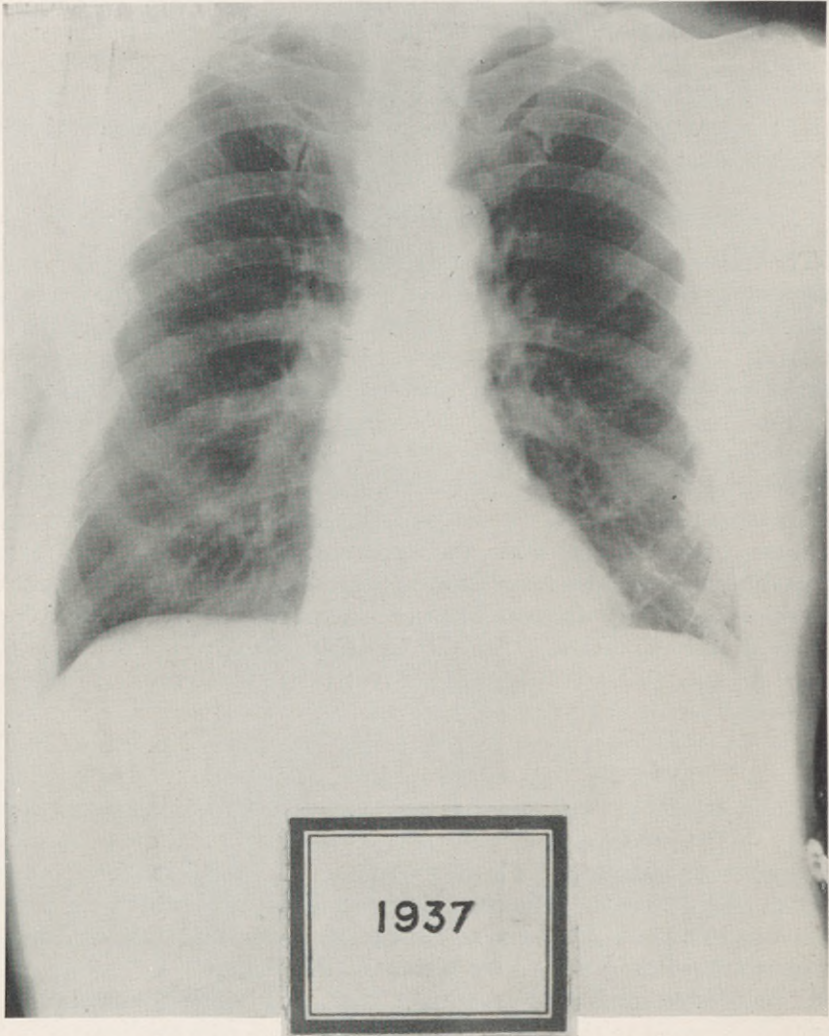
The first case presented in this series (see plate No. 39), did not have an X-ray at the time of the original examination. His age and length of service as well as his present chest condition is a great contrast to what has been shown in those workers who had dust exposure in dangerous amounts. He has been a machinist in the granite industry for 55 years. His condition was found to be about the same as it was in 1925 at the time of the first examination. He continues at his work without regard for his advanced years.

Plate No. 40 illustrates case 318. This man worked as a lumper and was exposed to the general plant atmosphere which averaged 20.2 million particles of dust per cubic foot. He was 55 years old at the time of the 1937 examination. A comparison of his X-ray with that of a granite cutter of the same age will reveal quite a difference. This worker has some signs of fibrosis but not sufficient to warrant a diagnosis of silicosis.

X-rays of case 171 were made in 1935 and 1938. (See plates Nos. 41 and 42.) He cut granite for 11 years but apparently this was

insufficient in time to produce evidence of silicosis. He changed to the occupation of sandblaster and used good protective equipment. As a result, he does not present evidence of silicosis in early 1938.

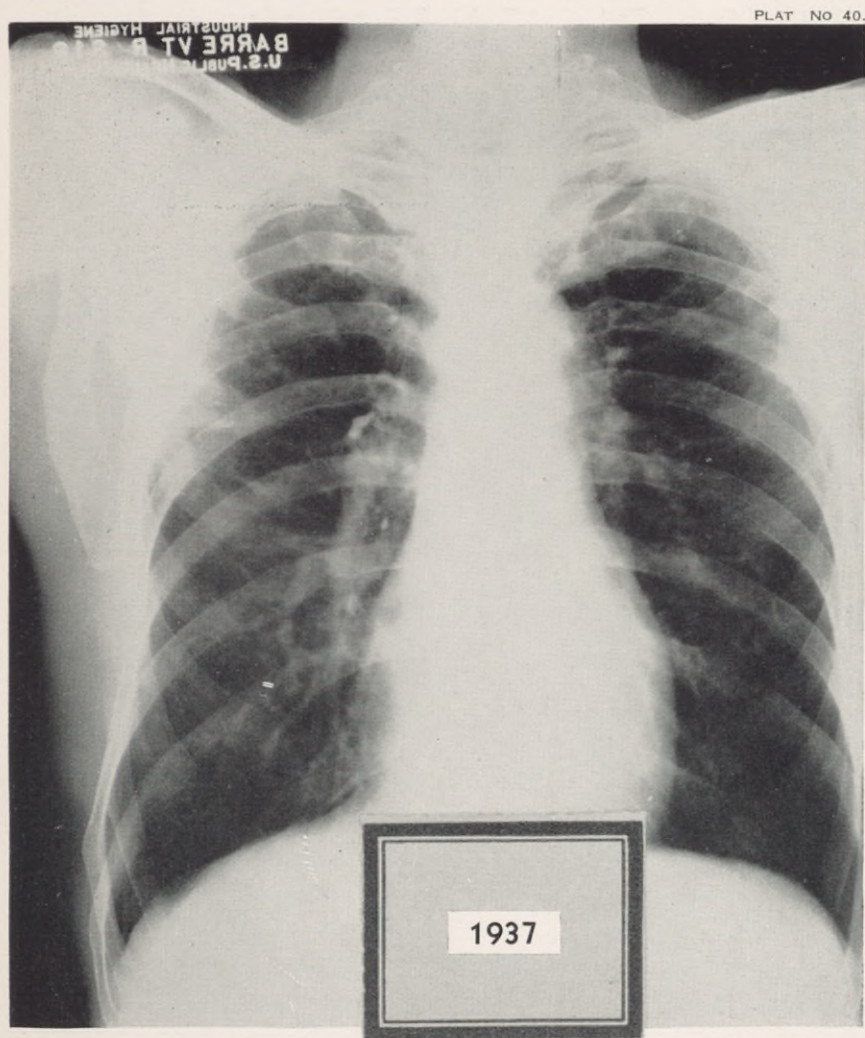
PLATE NO. 39.



CASE 288. F. E. L. EXAMINED APRIL 10, 1925. AMERICAN. AGE 61, HEIGHT 64 INCHES, WEIGHT 129 POUNDS. MACHINIST IN THE GRANITE INDUSTRY 43 YEARS, WORKING IN A SEPARATE ROOM. CHEST NEGATIVE.

EXAMINED AUGUST 6, 1937. AGE 74, WEIGHT 125 POUNDS. HE HAS CONTINUED TO WORK AS A MACHINIST SINCE PREVIOUS EXAMINATION. CHEST SHOWS SLIGHT FIBROSIS, CONSISTENT WITH HIS AGE.

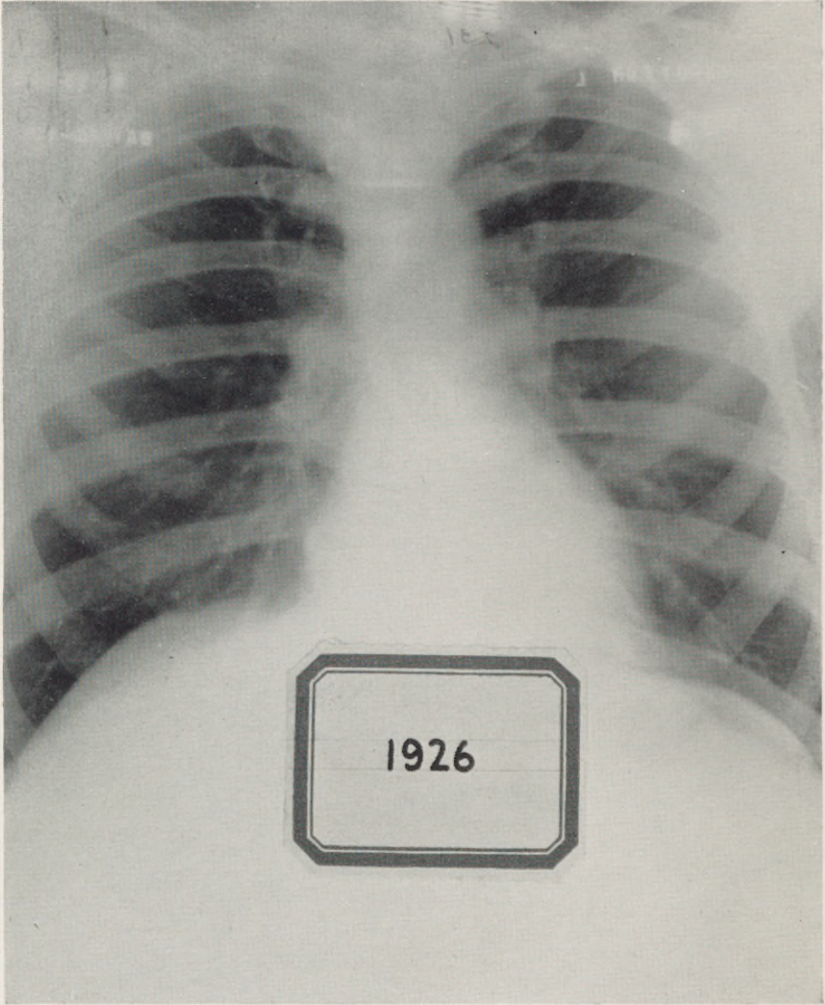
Table 3 summarizes the changes found in the low-exposure group (C-D). Those cases showing changes were for the most part workers who had been exposed to greater amounts of dust. The two with moderate progress had had exposure of this type—one for 20 years.



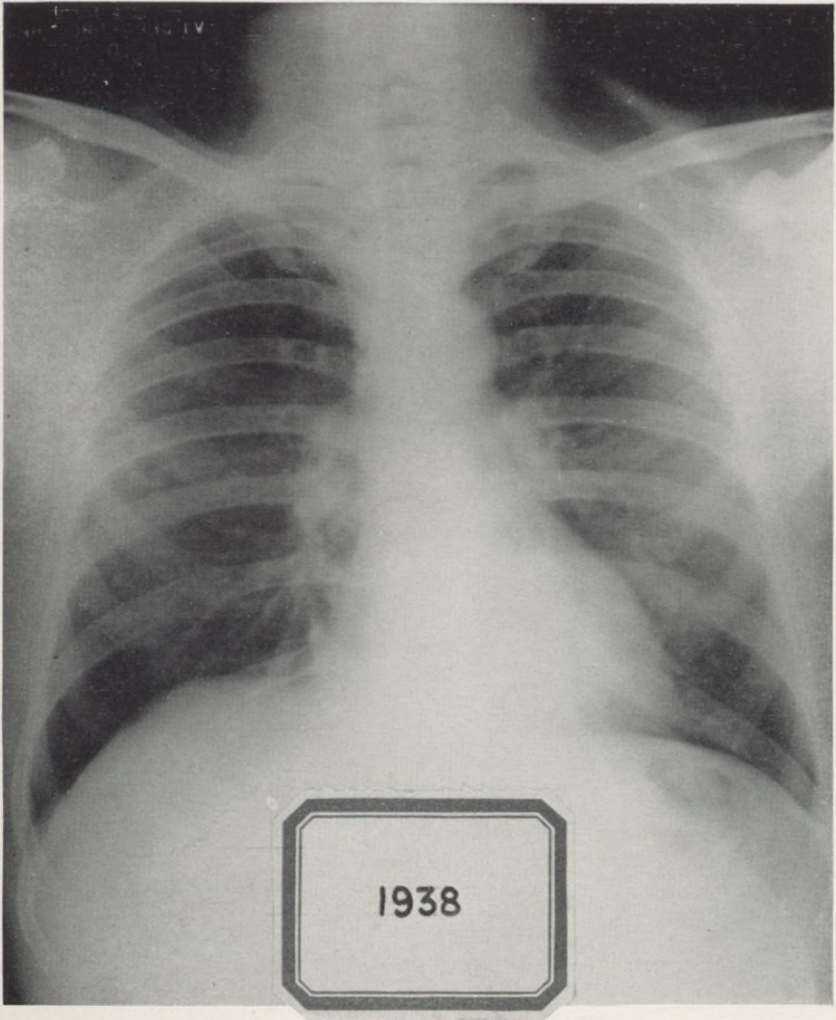
CASE 318. F. L. EXAMINED AUGUST 25, 1924. AMERICAN. AGE 43. HEIGHT 68 INCHES, WEIGHT 148 POUNDS. LUMPER 20 YEARS. CHEST ESSENTIALLY NEGATIVE.

RE-EXAMINED AUGUST 13, 1937. HAS CONTINUED WORK AS A LUMPER SINCE 1924. CHEST SHOWS MORE FIBROSIS THAN NORMAL.

PLATE NO. 41.

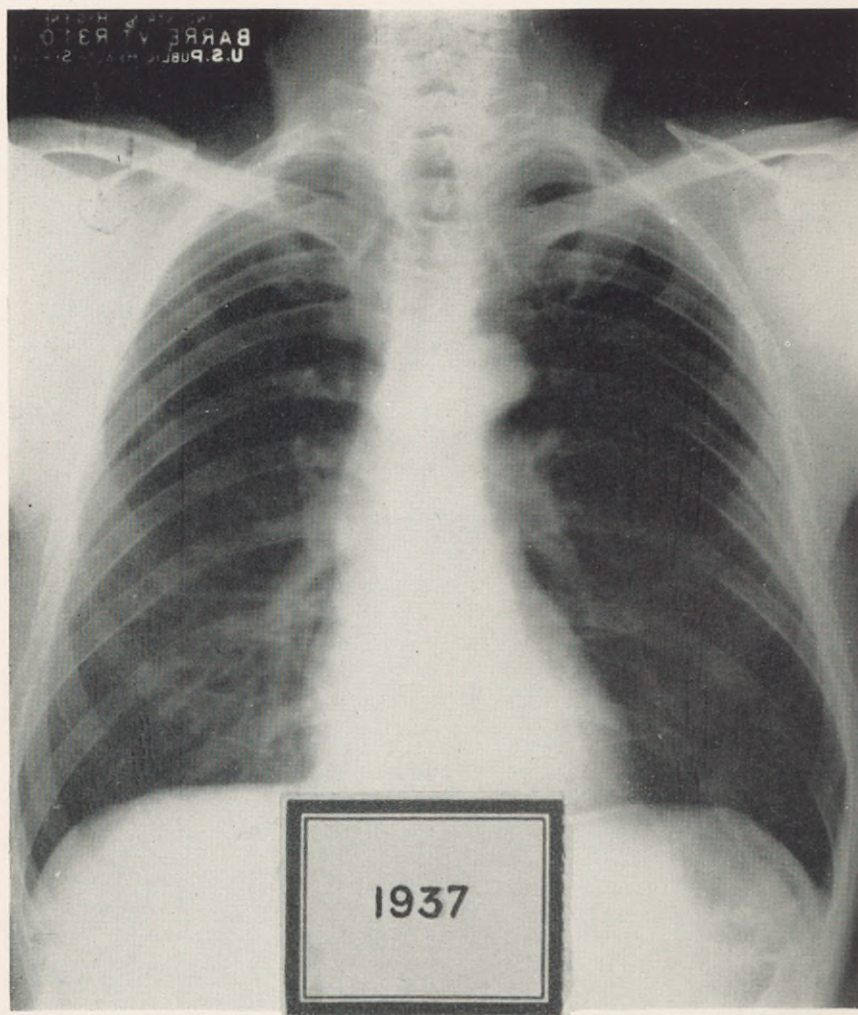


CASE 171. P. L. EXAMINED MAY 26, 1926. AMERICAN. AGE 29, HEIGHT 65 INCHES, WEIGHT 143 POUNDS. GRANITE CUTTER 11 YEARS. SAND BLASTER AND LETTERER 4 YEARS. CHEST SHOWS SLIGHT FIBROSIS.



CASE 171. P. L. EXAMINED JUNE 19, 1938. AGE 40, WEIGHT 161 POUNDS. HE HAS CONTINUED TO WORK AS A SANDBLASTER SINCE PREVIOUS EXAMINATION, AND FOR PAST 5 YEARS HE HAS USED CARBORUNDUM AND STEEL IN THE SANDBLAST PROCESS. HE HAS BEEN WEARING A GOOD POSITIVE-PRESSURE AIR HOOD SINCE HE BEGAN TO WORK AT SANDBLASTING. CHEST SHOWS MORE FIBROSIS THAN NORMAL.

PLATE NO. 43.



CASE 310. P. P. EXAMINED JANUARY 9, 1925. ITALIAN. AGE 37, HEIGHT 67 INCHES, WEIGHT 158 POUNDS. GRANITE LUMPER 12 YEARS. CHEST NEGATIVE.

EXAMINED AUGUST 9, 1937. AGE 50, WEIGHT 163 POUNDS. SINCE PREVIOUS EXAMINATION HE HAS CONTINUED TO WORK AS A LUMPER EXCEPT FOR BRIEF INTERVALS. CHEST NEGATIVE.

Table 3.—*Low-exposure group (C-D)*

Initials	Case No.	1937 age	Years in occupation by 1937	Diagnosis (1925)	Diagnosis (1937)	Progress	Remarks
F. A.	72	34	1	Negative for silicosis.	Negative for silicosis.	None	
A. C.	256	36	1	do	do	do	
G. R.	298	54	3	do	do	do	
C. H.	302	37	7	do	do	do	
H. W.	325	37	13	do	do	do	
D. G.	280	32	15	do	do	do	
J. S.	2	34	15	do	do	do	
G. T.	48	38	16	do	do	do	
A. T.	246	48	20	do	do	do	
J. L.	312	65	46	do	do	do	
F. L.	318	55	33	do	do	do	
W. B.	237	40	22	do	do	do	
P. P.	310	50	24	do	do	do	
P. P.	299	35	17	do	do	Slight	
K. L.	181	34	15	do	Latent tuberculosis right apex	do	Sandblaster—protected.
A. N.	303	34	16	do	More fibrosis than normal	do	
F. L.	288	74	55	do	do	do	
J. W.	125	47	30	do	do	do	
F. L.	182	45	26	do	do	do	
P. L.	171	41	23	do	do	do	
G. W.	108	53	34	do	do	do	
M. P.	287	41	21	do	do	do	
M. D.	77	38	15	do	do	do	
P. C.	260	61	22	do	do	do	
H. C.	235	58	26	do	do	do	
S. C.	234	53	33	do	do	do	
L. C.	96	46	28	do	do	do	
R. P.	254	46	29	do	do	do	
N. D.	241	63	30	do	do	do	
J. W.	304	51	31	More fibrosis than normal	do	do	
H. T.	36	46	16	do	do	do	
J. P.	48	47	22	Negative for silicosis.	Early silicosis.	Moderate	Formerly an anthracite coal miner.
A. B.	281	57	40	More fibrosis than normal.	do	do	

STATISTICAL SUMMARY

The following tables 4, 5, and 6, summarize some of the salient facts reviewed in the text. It should be borne in mind that this material suffers from the restrictions necessarily imposed by any quantitative analysis since medical diagnoses of this nature often do not permit of exact categorical classification. In general, all cases have been classified according to stages of silicosis and tuberculosis, but within the limits of those stages there are even finer gradations that are completely obscured in these tabular presentations. The author is fully cognizant of the questions of statistical validity that arise in this connection, but waives those questions in favor of offering some condensed form of this work which would otherwise be impossible.

Table 4.—*Granite workers. Chest diagnosis in 1925 compared with diagnosis in 1937 according to dust exposure groups*

Diagnosis	Groups A-B who continued at occupation		Groups A-B who changed to nondusty occupations		Groups C-D		Total	
	1925	1937	1925	1937	1925	1937	1925	1937
Tuberculosis—negative	64	39	18	9	33	32	115	80
Negative	21		1		30	13	52	13
More fibrosis than normal	2	2	4		3	17	9	19
Early silicosis	19	11	8	4		2	28	17
Moderate silicosis	21	15	5	5			25	20
Advanced silicosis	1	11					1	11
Suspect tuberculosis	1	8		3			1	11
Early silicosis	1						1	
Moderate silicosis		2		1				2
Advanced silicosis		6		2				6
Latent tuberculosis		1		1		1		3
Negative for silicosis		1		1		1		3
Active tuberculosis		21		5				26
Advanced silicosis		21		5				26
Total	65	65	18	18	33	33	116	116
Negative	21	1	1	1	30	14	52	16
More fibrosis than normal	2	2	4		3	17	9	19
Early silicosis	20	11	8	4		2	29	17
Moderate silicosis	21	16	5	6			25	22
Advanced silicosis	1	35		7			1	42

Table 4, the first of the series, presents the diagnoses with respect to silicosis and tuberculosis of 116 granite workers who were available for examination both in 1925 and 1937. These workers are divided in three groups, as in our previous discussion, according to dust

exposure. The first two groups, both of dust exposure class A-B, are arranged according to those workers who continued at their occupations until the time of reexamination in 1937 and those who changed their occupations subsequent to the first examination. It is clear from this table that both these A-B groups progressed in relatively impressive numbers, from the milder forms of silicosis to the more severe forms and often suffered the further complication of tuberculosis. In fact, since tuberculosis was so often present in the 1937 diagnoses, it was thought advantageous to relate the silicosis diagnosis to the tuberculosis diagnosis in this table. The 33 workers comprising group C-D show slight changes from early to later forms of fibrosis and silicosis, but it is clear that they are on the whole comparatively unaffected. Also in this group, there was only one case of latent tuberculosis and this worker did not have silicosis.

Table 5.—Granite workers. Progress from 1925 to 1937, compared with initial diagnosis

GROUPS A-B (EXPOSURE OVER 20 MILLION PARTICLES) WHO CONTINUED AT OCCUPATION								
Initial diagnosis with respect to silicosis (1925)	Progress in 12 years				Tuberculosis complications			Known deaths to 1940
	None	Slight	Moderate	Marked	Active	Latent	Suspect	
Total.....	1	2	31	31	21	1	8	18
Negative.....	1	2	14	4	2	1	3	2
More fibrosis than normal.....			2					
Early silicosis.....			9	11	6		2	5
Moderate silicosis.....			6	15	12		3	10
Advanced silicosis.....				1	1			1

GROUPS A-B WHO CHANGED TO NONDUSTY OCCUPATIONS								
	None	Slight	Moderate	Marked	Active	Latent	Suspect	Known deaths to 1940
Total.....	1	3	6	8	5	1	3	3
Negative.....			1					
More fibrosis than normal.....	1	3				1		
Early silicosis.....			5	3	5		3	
Moderate silicosis.....				5				3

GROUP C-D								
	None	Slight	Moderate	Marked	Active	Latent	Suspect	Known deaths to 1940
Total.....	13	18	2			1		
Negative.....	13	16	1			1		
More fibrosis than normal.....		2	1					

Table 5 presents the progress of disease in these workers compared with the initial diagnoses in 1925; again the table is divided according to dust count groups. In virtually all of the cases in the A-B groups, progress is moderate or marked; almost all of the workers in the C-D group progressed not at all or only slightly from 1925 to 1937. Of a total of 82 workers in the A-B group, 39 were active, latent, or suspect cases of tuberculosis as well; of this group, there were 21 known

deaths at the time of writing. There were no deaths in the C-D group, and only one case of latent tuberculosis. The reader should be again cautioned to interpret this table broadly since it is often difficult to classify degree of progress of silicosis to meet the requirements of a statistical table. The general conclusion to be drawn from these remarks is that apparently a high correlation exists among three interdependent factors: severity of original diagnosis, degree of progress, and dust-count group to which the worker belongs.

Figure 4 illustrates in graph form the comments that have been made on table 5. Marked and moderate degrees of progress account for almost all cases in the first two groups, while for group C-D, almost all cases were only slightly, or not at all, affected.

Table 6 is intended to show progress of disease in relation to the length of service, according to dust-count groups. It is evident from this table that those who serve longest are most subject to change in diagnosis from the less to the more advanced stages of the disease, particularly in the A-B group. This fact was suspected, of course, but it is interesting to note that statistical analysis confirms the suspicion.

A word should be added to explain that no attempt is made to offer much statistical interpretation since the figures are too small to justify elaborate computations. The tables and charts are presented as a visual aid to summarize quickly the cases discussed more fully in the text.

TABLE 6.—*Progress of silicosis by years in occupation and dust exposure groups*

	Groups A-B who continued at occupation						Groups A-B who changed to nondusty occupations						Groups C-D					
	Years in occupation to 1937																	
	0-9	10-19	20-29	30-39	40 and over	Total	0-9	10-19	20-29	30-39	40 and over	Total	0-9	10-19	20-29	30-39	40 and over	Total
Progress in silicosis—Total	8	27	21	9	65	1	4	9	4	18	4	9	11	6	3	33		
None	1	—	—	—	1	1	—	—	—	1	4	4	3	1	1	13		
Slight	1	1	—	—	2	2	1	—	—	3	5	7	5	1	1	18		
Moderate	6	18	5	2	31	2	3	1	—	6	—	1	—	—	—	2		
Marked	—	8	16	7	31	—	5	3	—	8	—	—	—	—	—	—		
Tuberculosis complications—Total	1	8	10	11	30	1	5	3	—	9	1	—	—	—	—	1		
Suspect	—	2	4	2	8	—	1	2	—	3	—	—	—	—	—	—		
Latent	1	—	—	—	1	1	—	—	—	1	—	—	—	—	—	1		
Active	—	6	6	9	21	—	4	1	—	5	—	—	—	—	—	—		
Known deaths to 1940	—	5	8	5	—	—	2	1	—	3	—	—	—	—	—	—		

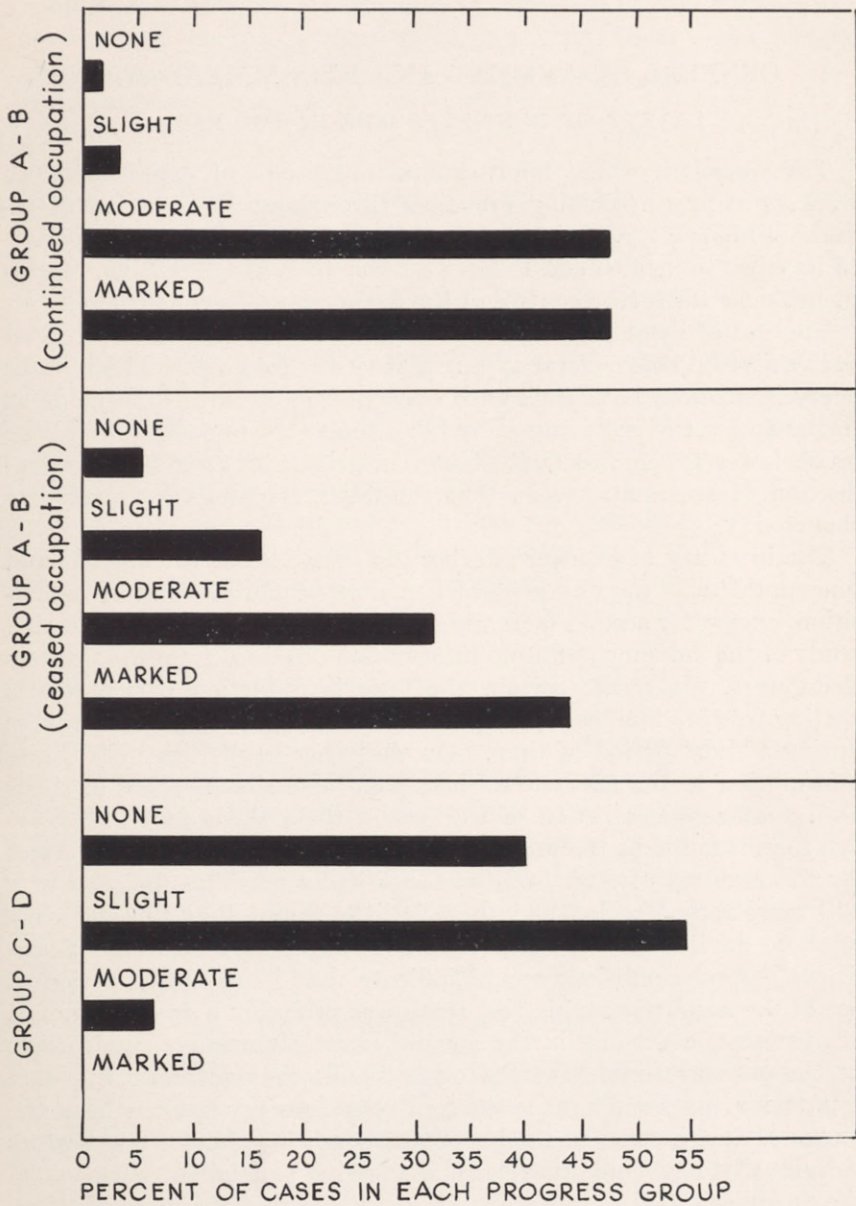


FIGURE 4.—PROGRESS FROM 1925 TO 1937 BY DUST COUNT GROUPS.

GENERAL STATEMENT AND RECOMMENDATIONS

EXTENT OF DUST EXPOSURE IN THE PAST

The question of the approximate magnitude of exposure of all workers in granite-cutting processes throughout their period of industrial life is a most important one, if we are to relate this exposure to its effect on health and to have a basis upon which sensible recommendations for future control of the hazard may be constructed.

The use of hand pneumatic tools in granite cutting in the United States first became general approximately 40 years ago. There seems every indication, both from such observations as have been made as to the amount of dust caused by hand tools (not pneumatic) and the much lower tuberculosis rate found in granite cutting before introduction of pneumatic tools, that the dustiness was very much less than today.

The intensity of exposure during the period since the use of hand pneumatic tools became general is a matter more or less of supposition, except for certain facts which have been gained from a personal study of the industry and from information obtained from the workers themselves. It seems certain that the introduction of pneumatic cutting was gradual, so that there was no abrupt change in dustiness during a short period of time. On the other hand, there is definite information to the effect that there were a smaller number of sheds and greater concentration of workers in these sheds 20 to 25 years ago than is found at the present time. The use of ventilating devices for the removal of dust from surface-cutting machines belongs to a still more recent period and there is little doubt that the efficiency of these devices had not been improved until in very recent years. These several conditions would indicate that in the early period of use of the hand pneumatic tool there was probably a greater amount of dustiness, especially in the general plant atmosphere, than exists at the present time. On the other hand, the fact that the dust counts for the hand pneumatic-tool operators were taken near the source of dust inclines to the belief that conditions for these operators individually have not materially changed since the introduction of the pneumatic tool.

PRACTICABLE LIMITS OF DUSTINESS

On the basis of the foregoing statements of the past record of dust exposure of granite workers, if we may accept them in a general way,

and our more accurate knowledge of the present exposure, together with the information obtained from the mortality and morbidity studies, it is possible to form some rough ideas of the limits of dustiness which may be regarded as reasonably safe from a health standpoint.

In estimating such limits consideration must be given to the record of tuberculosis and other sickness in the four dust-count groups, each having a known concentration of dust exposure. It was found that the A and B groups show unmistakable indications of the serious effect of the hazard. In those groups the average dustiness was from 40 to 60 millions of particles per cubic foot of air. Group C, which represented the occupations with a dust count equal to that of the general plant atmosphere, showed an average of about 20 million particles. There was little indication in the study as a whole of any serious effect on the men in this group. The death certificates showed, to be sure, unusually high proportionate mortality from tuberculosis among polishers and lumpers, who fall into group C. Confusion between occupations or change in later life from cutters to a less exacting occupation may explain part or all of the excess. But one would hesitate to be positive that no harm would come to persons working for many years under a concentration of 20 million particles. In group D, where the average concentration was 6 million particles, there was no indication whatsoever of any unfavorable effects on health, either from the physical examinations, the sickness records, or such mortality data as were applicable to this group.

From this line of reasoning, the average dust exposure for groups A and B must be considered as definitely harmful to the worker. There remains, then, group C in which, with an average exposure of 20 million particles, there is some question as to the harmful effect, and group D, with an average exposure of 6 million and a limit of 9 million, where no harmful effect is found. Thus it would appear that a safe limit lies somewhere between the amount of dustiness found in groups C and D or between 9 and 20 million particles.

THE VENTILATION PROBLEM

The practicable means of attaining such a limit of dustiness for all workers in the plants lies in the provision of adequate ventilating devices for hand pneumatic-tool cutters, so arranged as to remove the dust practically at its source. Figure No. 5 shows that this can be accomplished.

A few points of particular importance must be brought out.

First. Observations in certain granite plants in Barre and in other cities have shown that local exhaust devices can be economically installed which will reduce the dust count for the dust-making occupations to less than 20 million particles per cubic foot of air and

the general plant atmosphere to approximately 5 million particles. The cost of the devices installed in these plants was not found to be prohibitive; in fact, the dust problem had been met adequately in these plants with a comparatively small expense. The subject is covered fully in an article published in the United States Public Health Reports,⁷ both as to the required amount of air to be exhausted and the type of ventilating devices used.

The drawing illustrates the fact that the dust problem in granite cutting can be controlled by the use of efficient local exhaust systems. This schematic drawing was based on experience in a plant that had

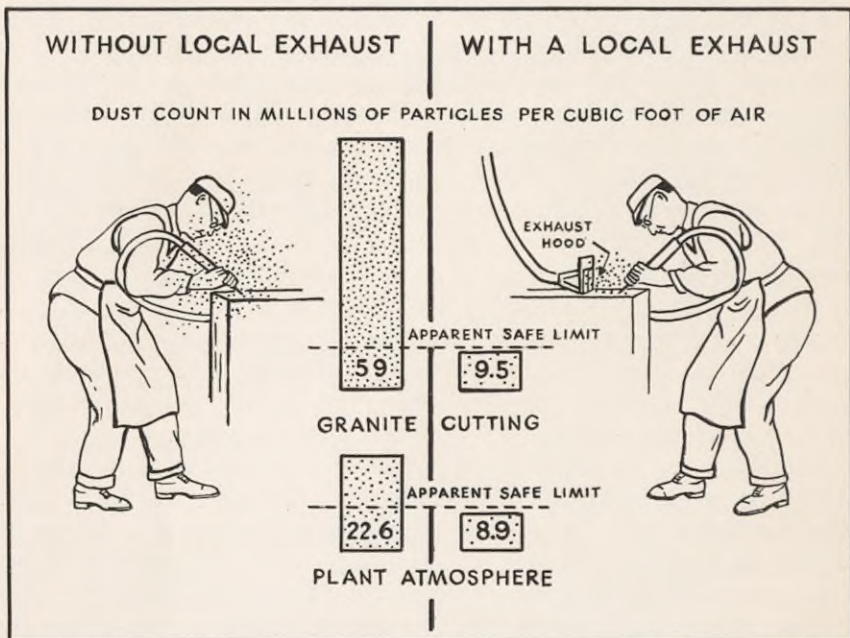


FIGURE 5.—USE OF LOCAL EXHAUST VENTILATION FOR HAND PNEUMATIC TOOL CUTTERS.

already been using exhaust equipment. A few years after the survey on which this was based, dust counts in this plant had increased considerably and the reason for the condition was neglect in maintaining the exhaust equipment in good condition. The cooperation of the State Board of Health by making dust counts at intervals and inspection of the equipment will prevent a repetition of such conditions.

Second. In observations made both in the plants in which the present study was conducted and in the plants in which proper types of ventilating devices had been installed, there is evidence of con-

⁷ Bloomfield, J. J. A study of the efficiency of dust-removal systems in granite-cutting plants. Public Health Reports. 44:2505-2522, 1929.

clusive nature of the necessity for the maintenance of these ventilating systems in proper running order through competent supervision of intelligent foremen or machinists, if the full value of the devices both from an economic and a health standpoint is to be maintained. It is impossible to emphasize this point too strongly. In the poor plants observed in this study, the ventilating equipment was not only of little value, but in the case of many of them, as shown by the comparison of summer and winter dustiness there was an actual menace to the workers because dust was blown back through the windows when open. Even in the better equipped plants improper placing of exhausts or clogging due to improper maintenance largely negated the full value of the devices.

Third. From observations in both types of granite plants, it is evident that, insofar as possible, ventilating devices which operate irrespective of the attention or desire of the worker himself are most desirable, and that common sense education of the worker to understand and utilize the devices which are provided for the protection of his health is a vital necessity.

Fourth. By segregating in separate rooms or buildings insofar as possible, those occupational processes in which little dust is produced, less dustiness will result.

Fifth. Adequate ventilation will remove the necessity for the use of masks in most instances. There are processes, however, that will require the added protection of hoods and masks. It is fortunate that the efficiency of this type of equipment has been established and most of the manufacturers of protective devices provide them with the stamp of approval of the United States Bureau of Mines on each article. When this equipment is necessary, care should be taken to provide Bureau of Mines approved devices.

MEDICAL SUPERVISION

The control of the intensity of dust exposure of granite workers will for the most part solve the important problems of the health hazards in this industry. On the other hand, it would seem wise that a check should be made as to this expected improvement in health conditions by medical supervision of the workers to prevent the entrance into the industry of individuals more than usually susceptible to tuberculosis, to remove workers from the industry if tuberculosis does develop, and, of most importance, to recognize the development of silicosis among these workers. Fortunately, this is being done by the State board of health.

This final question is far from being a simple one, since neither this study nor any other observations which have been made with respect to granite cutting in the United States give us information as to the

amount of silicosis which may develop without making the worker more susceptible to tuberculous infection.

This study does suggest several broad conclusions which appear to bear on this point. In group D, where there was exposure to small amounts of silica dust over long periods of time, there was no tuberculosis, although fibrosis did exist. On the other hand, the group of workers who had left the industry after severe exposure and gone into nondusty occupations appeared to develop tuberculosis to almost the same degree as workers who remained in the industry. This would incline to the belief that a moderate amount of fibrosis, slow in developing, is not incompatible with a long working life and is not a serious inconvenience to health; but that the contrary is true of a severe exposure even for relatively a short period, and that in these cases removal of the worker from the dusty occupation is of no avail. A clearer understanding of the factors which bear upon the developing silicosis and the susceptibility to tuberculosis must be reached. It is desirable that research work should be continued both in the laboratory and among workers exposed to silica dust to determine some of the points which have been raised in this summary.

What appears to stand out most clearly is that a maximum of dust exposure, falling somewhere about 10 million particles per cubic foot of air for the dust-making occupations, for a dust which contains from 25 to 35 percent of free silica in the form of quartz, is a desirable limit, and that it can be obtained by the use of economically practicable ventilating devices applied to the source of the dust.

Reference has been made several times to the varying concentrations and the chemistry of dust and the futility of trying to make a prognosis of the cases by the experience of others with different exposure. Table 7 is presented to bear out this statement as it shows the concentrations that have been accepted as permissible for the particular industries in the localities indicated. It can be seen readily that there can be no standard of permissible dustiness recommended for all industries. Separate limits of safety must be worked out for each industry presenting dust hazards.

The results of the studies of silicosis have been salutary. Granite manufacturers and workers and the people of Barre alike have welcomed and accepted recommendations based on scientific fact to eliminate the dust hazard of the industry. The concerted effort of the manufacturers to provide and install equipment to blot out this sinister plague of silicosis has been conducive to a better morale. Manufacturers, in tackling the dust problem and bringing it under control, now have at their disposal scientific advice and guidance of the State board of health through its bureau of industrial hygiene, with headquarters located in Barre. The lives of the workers are prolonged by the creation of better working condi-

tions and their fear of impending disability and ultimate death from tuberculosis is removed. Their lurking dread of the ravages of silicosis, once accepted with stoical resignation as inevitable, has given way to optimism and a happier outlook. In the future, older granite workers will gladly permit their sons to follow the trade in their footsteps, a thing they have been reluctant to do in the past. And likewise the results of the studies are a boon to the manufacturer who can face the future with the comforting knowledge that his industry will not produce an occupational disease as long as he provides and maintains adequate dust removal equipment. The manufacturer is assured that highly skilled workers will not be doomed to death prematurely because of the hazard of their trade at a time of life when they are most useful. At present the industry suffers because there is an acute shortage of expert carvers and statuary cutters due to premature deaths. The few remaining workers are in great demand because of the pressing need of their services; they devote themselves longer and more arduously than they wish in order to meet the demand for expert craftsmanship.

Table 7.—Permissible concentrations for the particular industries in the localities indicated ¹

Industry	Percentage silica in the dust	Permissible maximum safe dust concentration—millions per cubic foot
South Africa ²	80	4½
Ontario gold mines ²	About 35 (in the rock)	8½
Australia sandstone ²	90 (in the rock)	6
Barre granite ³	31 to 38	10-20
Pennsylvania anthracite coal mines ³	35	5-10
	13	10-15
	5	50
Broken Hill, Australia ²	10 to 17	14

¹ National Silicosis Conference, Bulletin No. 13, Division of Labor Standards, United States Department of Labor.

² Based upon engineering practice.

³ Based upon clinical studies.

In conclusion, because many persons outside Vermont confuse the granite industry with other stone industries of the State, it is necessary to repeat and to emphasize that the present report deals with the dust hazards of a particular industry where workers were exposed to a dust of known silica content and concentration. The deleterious effects of this dust have been known for a long time, the remedy for the hazard a much shorter time. It is gratifying to observe that there is a concerted effort and determination to make the industry safe. If the present trend continues, silicosis in the granite industry of Vermont will become a matter of history.

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